Journal of Chemical Education

Published by
Division of Chemical Education of The American Chemical Society
Easton, Pa.

Entered as Second-class Matter, January 31, 1924, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized January 31, 1924

Vol. II **September, 1925** **No. 9**

CONTENTS

	Page
Frontispiece—Michael Faraday Washing Apparatus for Sir Humphrey Davy	726
Editor's Outlook	727
The First Epistle of Henry the Chemist to the Uesanians. H. E. Armstrong	731
Some Suggestions for Modifying the Content of High-School Chemistry to Better Serve the Purposes of a Liberal Education. Raymond W. Osborne	737
Dr. Maclean and the Doctrine of Phlogiston. Wm. Foster	743
Study of Industrial Chemistry by the Unit Plant Research Development Method. Frank C. Vilbrandt	748
Dyes as Microchemical Reagents. H. J. Conn	753
Mournful Numbers. Louis C. Jordy	756
A Study of Pupil Errors in Chemistry. J. C. Bennett	760
A Comparison of Grades in General Chemistry Earned by Students Who (*a*) Have Had and (*b*) Have not Had High-School Chemistry. W. A. Everhart and W. C. Ebaugh	770
A Plan for the A. C. S. Prize Essay Contest. C. Allen Carlson	775
Definitions. Chas. H. Stone	778
The Use of Problems in Teaching Colloid Chemistry. F. O. Anderegg	780
Safety First in Storing Chemicals. H. F. Davison	782
An Automatic Blast Lamp. E. F. Ackelson and C. C. Kiplinger	784
An Analysis of High-School Texts in Chemistry. Arthur H. Bothe	785
Chemical Posters. Adeline H. Jacobs	792
The Students' Program at the Tenth Exposition of Chemical Industries, Grand Central Palace, New York, Sept. 28 to Oct. 3	795
Chemical Digest:	
Overlapping of High-School and College Chemistry—An Abstract	798
Synthetic Products	802
Subsidizing Accomplishment	804
Abstracts	805
Natural Science by the Experimental Method	
An Inexpensive Footlight Dimmer	
Chinese Camphor and Camphor Oil	
Significant Progress in Research in Photography	
The High School	
Tissue Transplantation	
Individuality and Uniformity in Education	
Jacques Loeb	
War Paint	
New and Rapid Method for the Removal of Phosphates in Systematic Qualitative Analysis	
College Curricula and Social Institutions	
The Business Value of Chemistry in Education	
Chemical Engineering	
Value of Industrial Research	
Metric System in Schools	
The Teaching of Applied Chemistry	
Technical Libraries	
The Atom's Amazing Secret of Power near Solution	
Chemical Engineering Aspects of Water Treatment for Railroads	
Refined Sulfurs: Their Manufacture and Uses	
Crodon	
Waimaugu and the Hot-Spring Country of New Zealand	
Doctor Sunshine	
The Correlation of Pharmaceutical and Medical Education	
Three-Year Course in Pharmacy	
Report on Chemistry	
The Oneness of the Universe	
The Histrionic Nature of Teaching	
Physical and Biological Science at Wembley	
Association Tendencies and Learning Ability	
The Discovery of Benzene	
Mercury Halide: A Correction	
Metal Resources and the Constitution of the Earth	
The Discovery of Benzene	
Faraday as a Chemist	
The Faraday Benzene Centenary	
Faraday and His Contemporaries	
Local Activities and Opportunities	816
Recent Books	818
A Few Moments with Our Business Manager	821
Institute of American Meat Packers	822

Michael Faraday Washing Apparatus for Sir Humphrey Davy

EDITOR'S OUTLOOK

The Frontispiece

IN THIS number the JOURNAL inaugurates a new feature. It is the intention to publish each month hereafter a reproduction of some work of art on a subject of interest to chemists or students of chemistry. We hope that teachers who are on the alert for material to supplement or humanize their prescribed courses of study will find these pictures helpful, and that to our readers in general they will present a decorative and pleasing innovation.

The present frontispiece is a copy of a picture which hangs in the Chemists' Club of New York City. We herewith acknowledge the courtesy of Mr. J. W. H. Randall who, on behalf of the Chemists' Club, has granted us permission to publish, as well as the kindness of Mr. Alfred O. Shedd of the World Book Company who furnished the photograph from which the plate was prepared.

Are Pupils People?

WE VIEW with approval the growing tendency to employ scientific methods in the investigation of educational problems. Undoubtedly too much of our writing and thinking has been based upon insufficient data. On the other hand we do not cherish the illusion that it is possible, nor the idea that it is desirable, to reduce education to the kind of science that could withstand the acid test of Lord Kelvin's definition.

Much of our information, it is true, must be obtained by subjecting classes to what may be termed guinea-pig experiments. There is nothing wrong with that. The potential disaster lies in attempting to apply our knowledge in the same spirit in which it was gained.

Facts, like milk, are most conveniently transported and stored when desiccated to the ultimate degree. As with milk, however, the process of desiccation should be reversed before the product is administered.

The writer recalls quite vividly the sense of discovery which, in his student days, attended a realization of the fact that many of his instructors were human beings in many respects like himself. Later, as an instructor, he had to make the same discovery concerning his students.

There is nothing new in this idea. Constantly we hear laments over the lack of personal contact between pupil and teacher where classes are large and instructors few. The personal relationship, however, depends fully as much upon the mental attitude of the instructor, and its inevitable reflection in the attitude of the class, as upon actual association.

All of us have listened to speakers who had that happy faculty of anni-

hilating the invisible but non-the-less tangible chasm which usually gapes between the platform and the first row. Occasionally a theatrical company succeeds in establishing with an audience that bond of fellowship which converts an otherwise casual evening at the theater into a memorable occasion. This is what the teacher must do as a matter of course.

We do not know who first evolved the conception that the teacher is a sculptor who, out of the mass of non-volitional clay presented to him in the guise of a pupil, seeks to model whatever his skill can contrive. Suffice it to say that we do not honor his memory.

Scientific Orthodoxy

AT A TIME when we have scarcely ceased to congratulate ourselves and thank whatever powers may be that we are not as the fundamentalists, we are perhaps little inclined to applaud a scientific H. L. Mencken who would, with one resounding blow of his slap-stick, atomize the bubble of our self-esteem. It is often prudent at such times, however, to pause momentarily and give ear to the ancient counsel which advises "him that thinketh he standeth" to "take heed lest he fall."

Are we in danger of accepting and—worse still—forcing upon our defenseless pupils scientific doctrines which are supported by little more than the sign and seal of authority? Professor Armstrong believes that we are. Many of our readers will, no doubt, feel inclined to take issue with him upon a number of the points which he raises. None, however, will attempt to deny the soundness of his injunction to "*prove* all things."

All men, it appears, are born credulous—some more so and some less. Not even the scientist is immune. The pages of chemical history are sprinkled with the names of men whose contributions to the advancement of science have been counterbalanced by the obstructive effect of errors which flourished under their protection. In science, at least, blind respect for authority ceases to be a virtue and orthodoxy is no subject for congratulation.

Is Culture a State of Mind?

ONE CANNOT ignore the fact deplored by several recent writers and speakers, that chemistry is not at present living up to its possibilities as an element in liberal education. Probably some changes in the content of our high-school and freshman courses are desirable. In this issue Prof. Osborne offers a number of suggestions relative to such changes.

One hears, furthermore, the criticism that the course of training which the average prospective chemist undergoes does not furnish the

cultural background desirable for a member of a group which aspires to recognition among the learned professions. This charge also deserves serious consideration.

The Journal of Education (London) suggests in a recent editorial comment that the cultural effect of a course depends upon the mode of presentation as well as upon the content. The point, we believe, is well-taken.

To the casual observer the methods of attack and the language of science tend to obscure the fundamental unity and magnify the superficial differences which exist between science and what are commonly considered the more humanistic studies. Some thought akin to this must have inspired Carruth when he wrote the oft-quoted verse:

A firemist and a planet,
A crystal and a cell,
A jelly fish and a saurian
And caves where cavemen dwell—
Then a sense of law and beauty,
And a turning from the clod.
Some call it evolution—
And others call it God.

Paul R. Heyl furnishes an excellent illustration in the *Scientific Monthly** when he quotes "The Psalm of the Sun" as a poet's version of the laws of energy.

Bow down, O my children: even worship me, ye men of wisdom.
As I rise upon you, and ye greet the morning: humble yourselves and be thankful!
For all that man possesseth is of me: and what hath any man that I have not given him?
Should I withhold my glory from the fields: or should I turn away from the watery mirrors,
Where then were the fruit of the earth: and where the dew of the morning?
Therefore rejoice, O my children, in my bounty: and bathe yourselves in my glory.
As I rise upon you and ye greet the morning: humble yourselves and be thankful!

We do not suggest that teachers should deliver their lectures in verse nor that they should necessarily adorn their discourses with references to the classics. After all, is there not a certain aesthetic virtue in the economy, precision and adaptation of the medium of expression to the purpose of the author, which characterize the language of science? If

* "The Humanist and I," *Sci. Mo.*, **21**, 176 (1925).

the layman fails to realize this, is it not because his unfamiliarity with the symbols employed obstructs his perception of the underlying thought? One does not criticise the language of the composer because the uncultivated ear cannot discern in the strains of his symphony nor the untrained eye read in the notes of his score, the meaning which he sought to express. Why damn a mathematical equation as an eyesore?

We realize, of course, that beauty of expression is in itself one phase of art. Too much attention to such external features should not, however, blind one to the more fundamental beauty of the thought expressed. The poet's love might not have appreciated his simile so much if he had likened her to a *Rosa Gallica*, yet, to the man who thinks in ideas rather than in words, the "red, red rose" is no less fragrant by that name. Some hint of all this, the inspired teacher will contrive to leave with his pupils.

The Prize Essay Contest

THE success of the previous prize essay contests has been, in no small measure, due to the interest and able support of the teachers of general science and chemistry. They have effected with eminent success that so-necessary liaison between the Prize Essay Committee and the prospective contestants. We believe that many of them would welcome an opportunity to exchange ideas on plans for promoting interest in the contest among their students. In this issue, Prof. Carlson outlines his plan, based upon the experience of the past two years. The JOURNAL invites other teachers to advance original ideas and helpful suggestions. Such contributions may, if the writer so desires, take the form of letters for publication in the proposed correspondence department.

THE FIRST EPISTLE OF HENRY THE CHEMIST TO THE UESANIANS

Henry, unto the Church of Chemists on the great continent. Grace be unto you and the peace of understanding. For the gospel is come unto you not in word only and also in practice but in much assurance, so that ye are ensamples to all. So being affectionately desirous of you, we are willing to impart unto you not the gospel only but also our own soul, because you are dear unto us. For this cause, when we could no longer forbear, we send to know your faith, lest by some means the tempter hath tempted you. Ye are all children of light and the children of the day. Therefore let us not sleep as others but let us watch and be sober. Comfort yourselves together and edify one another, even as also ye do. And we beseech you, brethren, to know them which labour among you and admonish you. And to esteem them very highly in love for their soul's sake. Now we exhort you, brethren, warn them that are unruly, comfort the feeble minded, support the weak, be patient towards all men. Quench not the Spirit. Despise not prophesyings. Prove all things; hold fast that which is good. We pray your whole spirit and body be preserved blameless. We charge you that this epistle be read by all the holy brethren.

Asked to send you, from across the waters, some message of experience, the old beautiful words rise up before me which are built fragment-wise into my epigraph.

At the moment, the Tennessee trial is forced upon our attention. Our Journal *Nature*, this week (July 11), has a special supplement, on *Evolution and Intellectual Freedom*, in which is published a number of opinions on the situation that has been created out of it. We may therefore well ask, "What is Intellect? Given intellect, what is freedom thereof? Have the many any intellect which can be free? Are even those free who claim to have intellect?" Freedom is a fine word but none perhaps is more abused. I recollect my surprise, long years ago, on first visiting the States, on hearing that the Bible was excluded from the schools of Minnesota—even as literature.

When we recollect that a leading agnostic, such as Huxley, as well as a most perfect writer of English, such as Ruskin, have been nurtured upon it—need we greatly fear its harmful effect? The literature of the opposite camp, which is without verbal charm, is not likely to help us greatly. Is not the parable of the ground upon which the seed falls the true reading of all such problems? Man, Anatole France tells us, is born either churchy or not churchy. The Press of the day is a sufficiently demoralising influence to correct the efforts of most to be intelligent or even merely good.

Should not intellectual freedom be the freedom, nay the obligation, to obey Paul's mandate to *Prove all things and hold fast that which is good?* Is this the teaching of the schools anywhere? Are we *proving* all things in

our chemical centers today? Are not most teachers just William Jennings Bryans in disguise, mere ranters of unproved statement? Mr. Bryan, I read in my *Nature*—an American professor of systematic theology, whatever that may be, tells me so—had learnt by long practice to make words do duty for ideas? We all do. It is our little way, characteristic especially of the physical school and also of the colloid—contracted apparently from the mathematicians, who, having said, "Let it be granted," thereafter persuade themselves that it is so, though it patently cannot be.

Several back numbers of the JOURNAL have been sent to me and I am not only edified thereby but much inspired. Thus, in No. 5, May, **1925,** I find an article on *New Life in Old Chemistry*. To me it seems today, our great need is, that a little of the *old* chemistry be put into our *new* life. We may well discard Colloids and the "dem'd" Donnan Equilibrium and Ions "by Ghosh" and get down to the understanding of teutonic *Sauerstoff* and French Lavoisier's *Oxygen*—seeking once more to cultivate the true faith and spirit of science, not a bastard counterfeit thereof. In tone, *Status Ionization Theory*, in the same number, reads like an early chapter in Genesis. I see no difference between the biblical statement—"And God said, let there be Light: and there was Light" and that of the Princeton Manual of Physical Chemistry—"And Arrhenius said, let there be Ions: and there were Ions." The Oklahoma man believes the one, the Columbia man the other: both equally on no ground of proof but because, by birth, each is a credulous creature. If Minnesota bans the one, it should ban the other. However, I must be careful how I use my intellectual freedom or President Murray Butler will hale me before the Beak.

The *Nature* essays on the Tennessee episode are full of tall talk, as to a "perilous interference with the teaching of fundamental philosophical principles," "human progress towards truth" and so on.

To what extent is the teaching of, 'science,' so-called in our schools effective in such directions? Are we in the least mindful, in such teaching, of the Pauline injunction: *Prove* all things—in construing the Gospel according to Ostwald any more than Oklahoma is in construing the Hebrew Bible? Princeton has recently furnished two big volumes of evidence that we proceed by faith and fancy, not by argument of fact. Is the general American public in the least able to appreciate the philosophy—I believe this is the appropriate highbrow term to use—of the Tennessee situation by reason of the training *in the use of scientific method* given in the schools? How many teachers in the schools could write an essay, giving a reasonable account of the nature of the method, which would gain marks? Prove this, my friends. My continued attempts to expound it (*see Essays on the Teaching of Scientific Method. Macmillan*) have had no visible effect on this side. "*For this cause, when we could no longer forbear, we send to know your faith, lest by some means the tempter hath tempted you.*"

The edifice we have erected in "science" is entirely lop-sided. We have made no attempt to carry the spirit of science into the minds of the many. Little wonder that the Bryanites furiously rage together against us. At least, on their side, they have a Bible filled with language of incomparable beauty, while we have not a single readable manual in which our doctrines are luminously set forth for adoration. Of what use is our research, our study of technical trivialities, while souls are searching above the sustenance which real knowledge can give? Some day it must be clear to us, how greatly we are failing in our duty to the community—how entirely selfish and material is our outlook. The Gospel, I fear, is "come unto you in much assurance"—and little modesty? Of what "are ye ensamples to all?"

Forty-five years ago, in 1880, I listened to an address on "Science and Culture," by the great scientific champion, Huxley, the centenary of whose birth we have just celebrated, at the opening of the College that has since blossom'd into the University of Birmingham. Huxley advocated the systematic teaching of "science" in schools, as a leading branch of ordinary education, *because of its cultural value.* Speaking from practically the same platform, last year, I had to point out that the hope Huxley and many other distinguished men had fifty years ago is in no way fulfilled. Here "Science" has no cultural value, as taught today. Not a student takes it, except to a vocational end. This is equally the case, I am led to fear, in the country of the Uesanians. The Essays published in Vol. **II,** No. 1, of the JOURNAL are sufficient to prove this. The examinees invariably dwell upon the material benefits to be derived from chemistry: no reference is made to its moral worth.

In illustration of my argument, I may be allowed to *prove* the article, *The Present Status of the Ionization Theory*, a title printed above a smiling portrait of James Kendall in THIS JOURNAL, p. 374, May, **1925.** Is he justified in smiling below such a title? Is he perhaps smiling at it? Is there an ionization *theory?* Very few theories are known to us. According to the Dictionary—

Theory is distinguished from *hypothesis* thus: a *theory* is founded on inferences drawn from principles which have been established on independent evidence; an *hypothesis* is a proposition assumed to account for certain phenomena and has no other evidence of its truth than that it affords a satisfactory explanation of those phenomena. It is necessary to keep this distinction in view, as the terms *theory* and *hypothesis* are very frequently confounded both in speaking and in writing.

Almost always, the word is used where guess, speculation or supposition (Greek—hypothesis), is meant, at best, an interpretation or doctrine. James Kendall must know full well that the doctrine he seeks to expound (defend?) does not afford a satisfactory explanation of the phenomena

generally which are brought under it: not half the facts can be fitted into it.

Then as to *status*, if I understand his essay, he does not consider the status of the doctrine but its state—the form to be given to it. I doubt if it has any real status today. Mellor said to me recently—"it is as dead as a door-nail." Unfortunately, door-nails often hold even when rusted.

Most important of all—what is ionization? Who can say today? The modern physical school has stolen the word *ion* from us and applied it to the electrically charged, *moving* particle, as distinguished from the uncharged, neutral molecule. There is no such implication in Faraday's original use of the term. The physicist should be brought before the Courts and condemned for infringement of our chemical copyright and trademark—forced to give up our word and devise a trade-mark of his own. Faraday taught, that chemical and electrolytic change were inseparable, reciprocal effects: the one always involving the other. He thought of the ion as both the chemical and the electrolytic unit but he neither asserted nor assumed that it was *free* prior to the event of change. Clausius first suggested that a few molecules in a solution were knocked to pieces, as the result of the numerous intermolecular collisions. Later, Arrhenius came forward as a whole-hogger and opined and asserted that, in very dilute aqueous solutions, the whole of the dissolved substance might be broken up into its chemically active units or ions. Years ago, I heard Huxley give a lecture in which, putting his palms together and then separating them, using the wrist as fulcrum, he said—"I do this and you will all gape." Most did. The world chemical was waiting for a sign and gaped at Arrhenius's command: swallowed him whole, in fact, big morsel as he was. Why? Largely because he made "research" easy—but research of the kind the draper's assistant in every store indulges in with his yard tape and about as fruitful and original in its results. The protests some of us made at the time were disregarded. A new cult was established. Even the sage van't Hoff fell a victim to the scare. The Gospel according to Arrhenius, with van't Hoff accompaniments, was rapidly written by their journalistic henchman Ostwald and sold at great profit. We all know how the Press can poison. The Pauline injunction—*Prove all things*—was unheeded.

I cannot write the school pedigree of James Kendall but I fancy he is out of Wilhelm Ostwald by James Walker. If so, the Bible first put into his hands told him "In the beginning was Arrhenius, etc." Being, like all Scots, innately pious and a child of faith, he did as he was told and never doubted. Apparently, he is still orthodox but his conscience is a little uneasy: the Colenso who will stir him to think for himself is yet to arrive.

In Arrhenius-land things just happen. Whatever salt-like substance be unfortunately dissolved in water just falls to pieces—out of sheer cussedness: where the energy comes from we have never learnt: the ions are born

at the expense of a non-existent bank balance. Such trifles are unconsidered—but laboratory chemists, we know, are prone to disregard economics. A little quiet hedging has been indulged in, J. J. Thompson suggesting that "ionising solvents" are liquids of high specific inductive capacity: a sort of gilt-edged security for the negative bank balance. I notice that James Kendall still fathers this myth, in referring to Werner's heretical views on water. Here again he is failing to *prove* his statements. He forgets to refer to the modern rational interpretation of the supposedly high dielectric constant of water: that this is a mixed value, made up of the true dielectric constant (a low value), to be deduced by Maxwell's rule from optical behavior, plus the charge taken by a condenser constructed of an electrolyte of high resistance, which behaves like the glass in a Leyden jar.

Arrhenius, who had little if any feeling for chemistry, at the time of his juvenile escapade, made the fundamental blunder of regarding water as something entirely different from hydrogen chloride. The hydrogen chloride molecules were thought of as possibly all falling to pieces in water, while the water molecules remained whole in presence of the chloride. Now if chemists know anything at all, it is that hydrogen chloride (HCl) and hydrone (H_2O) are comparable compounds—what is generally true of the one is generally true of the other: they are, in fact, twins, though of the non-identical kind: we may think of them as formed from a split ovum by two fathers.

Such considerations were entirely disregarded by the pachyderm Ostwald, who had no chemical feeling whatever: we pulled him up at Leeds but his hide was too thick to feel our blows.

Strangely enough, while classing water as a neutral, Ostwald and Co. insisted, and to the present day continue to insist, that it is "ionised" to a very, very slight extent. They not only admit that the ions of hydrone may be tempted apart but assert that it is fallen when at its highest. Why? Because Kohlrausch found the water he had purified as far as lay within his power to have a slight conductivity, which has been treated as intrinsic and still is, *e. g.*, in the *Princeton Manual*. It is useless to insist that *pure* water is and must ever be an ideal. It was refreshing to see the doubt thrown upon the character of water, by the physical school, called in question, in a recent issue of *Blue Bits*, by an American writer: one soul at least among you is seeking salvation by proving things. I trust this may be taken as a sign, that you may yet comfort yourselves together and edify one another.

It is yet to be proved that ions are ever free in a solution. The assumption is made by the Ostwaldians on the sole ground that any electromotive force, however small, will produce sensible electrolysis. This doctrine is also one that needs the application of the Pauline exhortation. It is based, I believe, upon the Helmholtz observation recorded in his Faraday lecture.

This is open to objection in the same way that the pure-water myth is. The experiment has not been made and cannot well be made: unpolarized electrodes are not to be had and if you start with a polarized electrode, energy may be gained in the transference of matter from the one electrode equivalent in amount to that expended in polarising the opposite electrode. The two fundamental postulates of the Arrhenic doctrine, in fact, are neither proved nor demonstrated.

In forcing the so-called ionization doctrine upon students, chemists are as guilty of intolerance as are the Bryanites—they are seeking to impose an unproved faith.

"Despise not prophesying," says the prophet. Yea, but he at once adds —"Prove all things; hold fast that which is good."

Arrhenius did the greatest service in correlating, to some extent, chemical with electrical behavior—but in no wise to the extent that is commonly supposed. What we have to resent is the refusal of Ostwald and his school to *prove* the interpretation that was put upon the facts and the dogmatic style in which the speculation is set forth, even in the latest text-books; still worse is their entirely partial and limited treatment of the subject of chemical change in general.

A couple of years ago, at the Cambridge International Conference, I challenged Bancroft to justify the narrow faith he professed. He declined to do so but said he would go home and read. Nothing has given me greater satisfaction, during the past forty years, than his statement, in a recent letter, that he had been led to see that we have too long left the properties of water out of consideration and must put aside the idea that it is a simple substance. Only when we know something of water will it be possible to understand the properties of solutions. Verily it is written—"And if any man think that he knoweth anything, he knoweth nothing yet as he ought to know"— again a Pauline precept.

The Uesanians pride themselves, we are led to believe, upon their mighty organised force of fifteen thousand chemists. Among these, judging from *Blue Bits*, there is already one sinner that repenteth. May the remaining fourteen thousand, nine hundred and ninety-nine so organise that, at no distant date, they may truly say: "We also are seeking to prove all things."

HENRY E. ARMSTRONG, F.R.S.

EMERITUS PROFESSOR OF CHEMISTRY,
CITY AND GUILDS ENGINEERING COLLEGE,
SOUTH KENSINGTON, LONDON

SOME SUGGESTIONS FOR MODIFYING THE CONTENT OF HIGH-SCHOOL CHEMISTRY TO BETTER SERVE THE PURPOSES OF A LIBERAL EDUCATION*

RAYMOND W. OSBORNE, FRANCIS W. PARKER SCHOOL, CHICAGO, ILL.

We are discussing chemistry this afternoon as part of, or as contributing to, a liberal education. All of us agree, I am sure, that we teach chemistry to our pupils so that they may become intelligent about the modern world in which we live, a world which is so conditioned by the contributions of modern chemistry and other sciences as to be non-understandable without such insight and knowledge as we try to supply. We believe that a course in chemistry yields dividends in more intelligent citizens, improved public health, more wholesome and hygienic home conditions, a higher and more enjoyable standard of living, a common-sense attitude towards nostrums of all kinds, both patent and political, and a genuine appreciation of the work of the chemist in serving the cause of humanity. These are some of the ideas which come to mind when we think of chemistry as playing a vital role in any plan for a liberal education.

Are we continually conscious of these purposes in our daily work, in the actual business of teaching in the class-room and laboratory? Is it not true that we think of these larger purposes as developing in a rather mysterious fashion, and that it would be rather difficult to say in just what way many of the topics we consider in our daily work bear directly on these aims of which we speak so glibly? Of course, many topics in chemistry are strictly necessary as *tools* of the subject; laws, theories, generalizations, valence, formulae and equation writing, computations, methods of testing and analysis, etc., must be taught thoroughly for the same reason that pupils cannot solve problems in arithmetic without having mastered their multiplication tables and control of the fundamental operations. But of that large group of topics that deal with the applications of chemistry to industry, manufacture, commerce, medicine, agriculture, and everyday use, a continual consciousness is needed on our part as teachers that these are the subjects which give the pupil insight into the ways in which chemistry is helping to carry on the work of the world, and it is largely through them that we build up the point of view, the connections, and the understanding which we believe should be gradually synthesized in the pupil's mind.

I suggest, therefore, these two criteria as a check on our choice of the subject-matter of high-school chemistry:

1. Is the topic necessary to give the pupil mastery of the tools of the science—the fundamental principles, concepts, theories, etc., on which chemistry is based and which it is continually utilizing?

* Address delivered at the University of Chicago Conference, May, 1925.

2. Does the topic provide information which is useful to the pupil directly or in the larger sense of showing relationship, answering questions, organizing information, arousing interest, and stimulating reflective thinking?

The history of science teaching in secondary schools shows clearly that with the possible exception of general science the introductory science courses in high schools have been pushed down from the colleges. The text-books used were shortened, condensed, and simplified forms of college texts, and written for the most part by college teachers. This is clearly true of chemistry. Of late years we have had a number of text-books written by high-school teachers especially for high-school students. A comparison of these texts with the earlier ones shows surprisingly little difference in content and method of treatment. Books have been kept up-to-date, newer conceptions of the nature of matter and of the interpretation of chemical reactions through the theory of electrolytic association have been introduced, and descriptions of newer developments in industry and manufacture have replaced those of older processes and methods. The main plan of organization was and is the same. First, the introduction of fundamental principles, laws, and theories by a study of the chemistry of oxygen, hydrogen, water, the atmosphere, etc.; second, the development of conceptions of atomic weight, molecular weight, valence, formula writing, chemical computations, etc.; third, a more or less systematic study of the more familiar elements. The study of an element usually follows this order: occurrence, the production of the free element and its chemical and physical properties, its uses, important compounds, their manufacture, uses, and applications. Chapters on the periodic classification, on food and nutrition, on the radioactive elements, and on the simpler aspects of organic chemistry, are usually included.

The fact that there has been so little change in the content of the chemistry course as represented by the commonly used text-books is in itself sufficient reason to call for a critical examination of this traditional subject-matter in the light of modern educational principles.

It is now generally agreed by educators that pupils develop most rapidly when they are interested in the work they are doing, and when the subject-matter dealt with provides foundation for such real and continued interest. Interest on the part of the pupil is the starting point. If faint, it needs stimulation before real progress can begin; and if lacking, a spark must be struck to kindle it before a beginning can be made. Interest, however, soon lags unless based upon appreciation of the purposes which the work undertaken serves. Pupils cannot be held to continued strong endeavor unless the task imposed seems of real value to the pupils at the time those tasks are being performed. It is by such purposeful

endeavor, calling into play all the powers of the mind, that real educational growth takes place and self-discipline is gained.

It seems to me that some, at least, of our chemistry teaching does not square up with this principle of sustained interest based upon the appreciation of real values to be derived from the work being done. The pupil reads the text-book because so many pages have been assigned by the teacher, and not because he has questions in his mind which he wants answered. He performs his experiment mechanically and not as an opportunity to get first-hand information from actual experience with the things themselves. A great deal of the difficulty comes, I think, from the fact that we leave off at the point where we ought to begin. For example, the pupil is not likely to be interested in the paraffin series of hydrocarbons, with the general formula of C_nH_{2n+2}, but in gasoline and lubrication oils for the family automobile. Therefore, we should begin by studying the refining of petroleum into these products and work back naturally and incidentally to the homologous series of hydrocarbons. Again, the average pupil is naturally interested in glass-making and the production of familiar varieties of glassware. The element silicon, as a topic for study, fails to make use of the experience and interest already in the pupil's mind until he comes to that section of the usual chapter which deals with glass manufacture. Alloys, anti-friction, and low-melting, would be a better starting point from which to teach much that is now studied disconnectedly under antimony and bismuth. Why not entitle a chapter "The Chemistry of Photography," and present that topic thoroughly and adequately rather than reduce this interesting application of chemistry to a few paragraphs in a chapter on silver? Blueprints should be treated in the same connection, and not brought in as an isolated paragraph under iron compounds.

A little thought will suggest many other similar changes in introduction and emphasis on familiar topics which would better utilize pupils' interests and make them feel the immediate and practical value of the work studied at the time that work is begun and not towards its conclusion.

Text-books need not be rewritten to bring about this change in method. The teacher can call the attention of the pupil to these points by intelligent assignments, pointing out in the advance lesson the applications and uses which are most likely to arouse his interest and to make his study more purposeful.

One of the most significant developments of the last few years is the great increase in the number of science books of a sound but popular character, written primarily to interest the public in the work of science, to make people generally more intelligent about the services of science to the richer and more satisfying life of today. We have a great number of such books dealing with chemistry: Slosson's Creative Chemistry, Duncan's Chemistry

of Commerce, Tilden's Chemical Discovery, Martin's Modern Chemistry and Its Wonders, Findlay's Chemistry in the Service of Man, are but a few which come quickly to mind. Most of our chemistry text-books have at the ends of chapters a list of topics for further study, with references to those more popular discussions of chemistry. These references often deal with topics which are naturally of greatest interest to pupils. As time goes on more and more of this material is likely to find a place in our text-books. But in the meantime let us include some of this reference material in our regular assignments and see to it that our pupils get the inspiration and impetus which it is likely to supply. The difficulty here is that too few schools can have available a sufficient number of such supplementary reference books to make class assignments to them easily possible. This difficulty can be overcome in part by having individual pupils work up such topics in advance and present them briefly to their fellow students as part of the regular class work. Class time so used is often most valuable and stimulating to lagging interest by reason of the questions and discussions which such reports can arouse if well prepared and presented.

One of the most serious criticisms of present chemistry text-books is the very large number of more or less unrelated topics. These isolated topics add greatly to the difficulty of the pupil and often demand powers of organization beyond his ability. One reason for this has been touched upon already—the commonly accepted plan of organization under separate elements. I believe chemistry texts will in time be organized differently, upon the basis of industries and applications rather than upon the elements as arranged in the periodic system. To illustrate: chemistry has an extremely important function in maintaining soil fertility. This topic is dealt with in part under nitrogen; again under potassium; again under phosphorus; and again under calcium. A chapter or large topic on "Feeding the Soil," which would bring together these separated facts and organize them into one valuable and important unit could easily be constructed. The metallurgy of the common metals is another example of separated information which can very well be considered a unit involving general principles which the pupil usually fails to get when the metals are treated separately. A grasp of these general principles of metallurgy helps to organize this separated information, and so gives the pupil mastery and the ability to use his knowledge because he sees relationships. A third, but briefer topic of this same sort, might be entitled "Artificial Stone," under which would be organized information concerning cement, plaster of Paris, mortar, plaster, concrete, stucco, etc.

The field of applied chemistry is so vast and so varied that the elementary course cannot possibly deal with any but the most important aspects of it. Text-books, in their effort to include as much as possible

in the fewest pages, have often boiled down the consideration of a topic until all the interest has been squeezed out of their treatment. It is my belief that we need a fuller and more adequate treatment of the industrial and application side of chemistry than we now have, with the idea that the choice shall rest with the teacher as to which topics shall be stressed and which eliminated, according to his location in an industrial or rural community, and considering the needs and interests of the particular group of pupils being taught.

A too-brief, encyclopedic treatment of a topic defeats its own end; it fails to make sufficient impression upon the pupil's mind, and the result is that it might as well be omitted altogether. If such a topic is to register more than a fleeting impression, the teacher must find some means to supply additional and supplementary material to make it meaningful to the pupil. I offer here a brief list of such topics, drawn from a commonly used text-book which seem to me to illustrate this point:

Refining of Petroleum
Nitrocellulose
Coal Tar Products
Paper
Clay and Pottery
The Spectroscope and the Composition of the Stars
Glass
Cement
Atomic Numbers
Rare Elements

These and other topics are worthy of a far fuller treatment than they receive in our present text-books. The teacher may supply additional information to his class or supplementary and reference books may help to overcome this difficulty in part. Since, however, only a minority of pupils can be expected to make use of such reference books, a fuller treatment in our text-books would benefit chemistry instruction and enable it to contribute more effectively to a liberal education.

Summary

To summarize what I have tried to say: First, make the application side of chemistry, its connections to industry, to manufacture, to health, and to everyday experience at home and in school, the starting point in as much of our study as possible. Towards this same end utilize the material in the newer books written to popularize chemistry, stimulating in style and yet based on sound science.

Second: Reduce the number of isolated topics which the pupil must learn by developing a number of new units or topics which will organize naturally and psychologically some of the information now scattered under various elements in isolated paragraphs.

Third: Cut out certain topics and increase the amount of attention given to others. This means selection by the teacher and not following the text-book from cover to cover.

Fourth: Topics worthy of any attention should be presented fully enough to make a real impression, establish relationships and connections, so that the necessary organization by the pupil will be easy and natural, stimulating rather than destroying interest.

Transparent Steel Finds Many Uses. The new method of making sheets of metal of unprecedented thinness, invented by Dr. Karl Mueller of the Physical Technical Institute of Berlin, seems likely to prove of considerable industrial as well as scientific importance. He has succeeded in producing sheets of steel so thin that they are as transparent as the clearest glass. The test plates used to determine the transparency of optical glass, and ruled with lines one-twenty-five hundredth of an inch apart, were photographed through such a metal sheet, and when enlarged to four hundred diameters the scale lines showed distinctly without any distortion. This absence of aberration proves that the structure of the film is perfectly even and equal in all directions. The metal sheets are so thin that atoms will pass through them without impediment. Alpha rays from radium, that consist of streams of the stripped atoms of helium, and are completely blocked by a sheet of paper, are not perceptibly weakened in passing through such metal sheets. It is calculated from the specific gravity of the metal that in these sheets there are not more than thirty layers of atoms in thickness. Yet the sheet of metal is so strong that when fastened in a frame it may be bent out by blowing on it to a sixteenth of an inch without rupture.

Dr. Mueller makes these sheets by depositing an extremely fine film of the metal on a smooth surface by means of the electric current and afterwards separating the film from the foundation on which it was fixed.

Many applications have already been made by scientists and inventors to secure these transparent metal sheets for experimental purposes. They seem likely to serve as semi-permeable membranes for the separation of gases. They may greatly advance the progress of telephotography and television. They also seem likely to prove serviceable in metallurgical research, and in the making of galvanometers, radio receivers, and apparatus for measuring the action of the heart.—*Science Service*

Inert Chemical Elements Show Some Signs of Activity. Three of the most unfriendly of all the elementary substances known to chemists, substances that have never been believed to have anything whatever to do with other chemical elements, not even with members of their own family, have now been persuaded to be a little sociable with the chemical compound, water.

M. de Forcrand of the French Academy of Sciences has just announced that he has obtained the heretofore inert gas xenon in crystalline form combined with 6 or 7 molecules of water. It was made in a Cailletet apparatus when pure xenon in the presence of a little water was subjected to a pressure of several atmospheres. The crystalline form of krypton had been obtained by him two years before, and the French scientist M. Villard discovered that of argon. But the xenon compound is the most stable of these.

Three of the six known "inert" gases still remain obdurate, and among these is helium, the non-inflammable balloon gas.—*Science Service*

DOCTOR MACLEAN AND THE DOCTRINE OF PHLOGISTON*

WILLIAM FOSTER, PRINCETON UNIVERSITY, PRINCETON, N. J.

Plato assumed that all combustible bodies or substances contained a common element—an inflammable principle—which enabled them to burn. This explanation of combustion was quite generally accepted until the eighteenth century. Geber, for example, who is supposed to have lived in the ninth and tenth centuries, and was the most celebrated of Arabian alchemists, thought that the inflammable principle was sulfur; hence the expression, "where there is fire and heat, there is sulfur."

Becher, in 1669, pointed out that there are many combustible materials that do not contain sulfur; and he postulated a principle termed by him *terra pinguis*, fatty or inflammable earth. Subsequently Stahl, who was a professor at Halle and a good chemist and successful teacher, developed Becher's hypothesis and gave the name *phlogiston* (Greek, *I set on fire*) to his *terra pinguis*. It is well known to all chemists that Stahl and his followers held that, when bodies burned or when metals were calcined, a sort of fire-stuff (phlogiston) escaped. Nobody seemed to have a very definite notion as to the real nature of phlogiston. Some thought that sulfur and soot were nearly pure phlogiston. Others thought that phlogiston was immaterial, or light, or hydrogen. The principle was supposed to be united with combustible (*phlogisticated*) bodies and to be separated from incombustible (*dephlogisticated*) bodies. Combustion was regarded as a decomposition rather than the union or combination which we now know it to be. The metals, phosphorus, sulfur, and many other bodies were supposed to be compounds, consisting of phlogiston and another constituent which was termed its *base*. Thus, a metal was regarded as phlogiston united to a *calx*, and phosphorus and sulfur were regarded as the same principle in union with their respective acid, or the bases of them.

Phlogiston became very thoroughly entrenched in the eighteenth century, being advocated by all the leading chemists such as Scheele, Cavendish, Black, and Priestley; hence Langley wrote: "During the greater part of the eighteenth century the doctrine of phlogiston was not only the lamp and guide of chemists but it remained the time-honored and highest generalization of physical chemistry for over half a century."

Soon after the discovery of oxygen Lavoisier (1777) published his celebrated oxidation theory, which led to the overthrow of the doctrine of phlogiston. One by one leading chemists saw that the doctrine was no longer tenable, so in the course of time it was thoroughly discredited. As stated by Odling, "Phlogiston died as an old king—once infinitely dominant, somewhat tyrannical, not always just; now deposed, decrepit, utterly senile, forsaken by all."

* Read before the Historical Section of the A. C. S. at Baltimore, April 9, 1925.

Just twenty years after his discovery of oxygen, or in 1794, Priestley emigrated to America and lived at Northumberland, Pa. By this time the *new system of chemistry*, or that of the Antiphlogistians, was quite generally accepted by philosophers and chemists. Dr. Priestley, however, still believed in the phlogistic theory; and in final defense of the doctrine he published, in 1796, an essay, entitled, "Considerations on the Doctrine of Phlogiston, and the Decomposition of Water." In his introduction he wrote:

> There have been few, if any, revolutions in science so great, so sudden, and so general, as the prevalence of what is now usually termed the *new system of chemistry*, or that of the *Antiphlogistians*, over the doctrine of Stahl, which was at one time thought to have been the greatest discovery that had ever been made in the science. I remember hearing Mr. Peter Woulfe, whose knowledge of chemistry will not be questioned, say, that there had hardly been anything that deserved to be called a *discovery* subsequent to it.

Priestley went on to say that the new system of Lavoisier had been accepted by the principal philosophers and chemists of England, Scotland, and America. He said he hardly knew of anyone, except his friends of the Lunar Society of Birmingham, who adhered to the doctrine. In his essay he wished to make one more appeal to the philosophical world to show that the doctrine of phlogiston was correct.

In 1795, one year after Priestley emigrated to America, there came to our shores a clever young Scotsman, Dr. John Maclean, of Glasgow University. Shortly after his arrival, Maclean was elected professor of chemistry and natural history in the College of New Jersey (Princeton). He had been thoroughly trained in medicine, surgery, and chemistry, having completed his education in Paris, where Lavoisier, Berthollet, and other famous chemists were busy with their investigations; and he was no doubt greatly impressed by their discoveries and teachings. Therefore, when Dr. Maclean assumed his duties at Princeton, he was a thorough believer in the antiphlogistic doctrine; and two years later (1797) he prepared "Two Lectures on Combustion: Supplementary to a Course of Lectures on Chemistry Read at Nassau Hall. Containing an Examination of Dr. Priestley's Considerations on the Doctrine of Phlogiston, and the Decomposition of Water." As Dr. Maclean had other engagements, a part only of the first lecture was read to his students; they were printed, in 1797, by T. Dobson, at the Stone-House, No. 41 S. Second St., Philadelphia, "to save the young gentlemen the trouble of transcribing them."

It should be noted that Dr. James Woodhouse, a native of Philadelphia and a graduate of the University of Pennsylvania, was a contemporary of Maclean, and, like the latter, an advocate of the chemistry of the French School. Certain contributions of Priestley, which appeared in the "Transactions of the American Philosophical Society" at the close of the eighteenth

century, were discussed by Dr. Woodhouse. His replies to Priestley consisted chiefly of experimental refutation of the statements of the discoverer of oxygen. In his opposition to Priestley, Woodhouse was always respectful. Other American writers, among whom was Dr. Maclean, were inclined to belittle the contributions of Priestley. Woodhouse felt called upon, therefore, to answer one of Maclean's attacks on Priestley. Accordingly, he addressed a letter to the young professor of Nassau Hall, and among other things he said: "You wrote your dissertation expressly to prevent the youth of Princeton College from falling even into temporary delusion, and as a public controversy is always favorable to the cause of truth, you can have no rational objection to this letter." In his letter, Woodhouse stated that some of Maclean's assertions were erroneous.

Let us now examine some of the views entertained by Priestley concerning the doctrine of phlogiston, as well as the answers published by Maclean.

In the first part of his dissertation, Priestley treats of the *constitution of metals*. He held that metals are *compound substances*, one of the constituents being phlogiston, which is proved when iron is dissolved in such an acid as vitriolic (sulfuric). With regard to mercury he wrote: "A decisive evidence, as it appears to me, that mercury contains phlogiston is the absorption of a great proportion of inflammable air in the revival of red precipitate in it." It appears, therefore, that he regarded "inflammable air" (hydrogen) as phlogiston.

According to Maclean, "the antiphlogistians consider metals as simple, because they have not discovered them to be compounds; and they believe the substances, which the doctor calls calces, are compounds of metals and one part of the air, which they call oxygen, because they cannot be formed without the presence of oxygen; they exceed in weight the metal, and this excess corresponds to an equal loss of oxygen; and the oxygen may be recovered entirely, in the state of gas, from the red oxide of mercury, by simply raising the temperature." Dr. Maclean admitted that the presence of hydrogen gas and other combustible substances renders the reduction of the red oxide of mercury easier; but according to his reasoning, this only proves that the substance is decomposed more readily when there is a substance present capable of combining with one of its constituent parts, namely, the oxygen, a circumstance analogous to many other chemical decompositions. "The antiphogistians are indeed to believe that hydrogen is not imbibed by the mercury, but combines with the oxygen, because, first, oxygen gas may be collected when an oxide of mercury is reduced by simply raising its temperature; second, when reduction is performed in hydrogen gas, this disappears, no oxygen gas is obtained, but a quantity of water may be collected; and, third, from various experiments it seems that water is a compound of hydrogen and oxygen."

The working of Dr. Maclean's logical mind is shown to good advantage

in the following statement: "If two portions of matter exhibit the same phenomena in all chemical operations, they ought most certainly to be considered as the same substance; and as mercury revived from its oxides by a mere increase in temperature possesses all the properties of that revived by the assistance of hydrogen gas, etc., it cannot be in any respect deficient."

In one experiment, Priestley exposed iron, confined in air, to a burning lens, in consequence of which the air diminished in volume, and the metal became a calx. He thought that something was emitted from the iron, for he observed a strong smell arising from it. "If the process be continued," he wrote, "inflammable air will be produced, if there be any moisture at hand to form the basis of it." It was his opinion that the substance or principle, which he claimed escaped from iron, was phlogiston!

Maclean, on the other hand, showed that the escape of inflammable air (hydrogen) was due to iron uniting with the oxygen of the water, the hydrogen assuming the form of a gas or air.

After considering the effects of air upon metals at high temperatures, Priestley took up the consideration of those of acids upon metals. He thought that the inflammable air (hydrogen gas) emitted by dissolving iron in acids was due to the decomposition of the iron; and that "*finery cinder*" (black oxide of iron) does not contain oxygen.

In answer, Maclean said: "Iron, when dissolved in sulfuric acid, is reduced to a state like that of the black oxide. And, further, if it can be proved that water is a compound of hydrogen and oxygen, and susceptible of decomposition, as is insisted by the antiphlogistians, it must also follow, that hydrogen gas, and other inflammable substances, assist the reduction of metallic oxides, by combining with their oxygen."

Dr. Maclean was right in holding that the hydrogen gas obtained by exposing heated iron to moisture comes from the decomposition of the water; but was in error in contending that the hydrogen gas obtained by dissolving a metal in an acid is furnished by the decomposition of water.

Neither Priestley nor Maclean understood the displacement of the hydrogen of an acid by means of a metal.

The antiphlogistians had declared their firm belief in the formation, the decomposition, and recomposition of water; but Priestley did not have complete confidence in their experiments. He still maintained that the doctrine of phlogiston accounted for all they had observed. Maclean knew that when steam is passed over red-hot iron, the loss of water is exactly equal to the joint weight of the addition to the iron, and of the hydrogen gas obtained; and he supposed the addition made to the iron to be oxygen, because the compound resembles, in every respect, the substance formed by burning iron in oxygen gas.

The antiphlogistians burned dephlogisticated air (oxygen) in inflammable

air (hydrogen) and obtained water, the weight of water being equal to the sum of the weights of its constituents. Priestley doubted their results, and contended that finery cinder (black oxide of iron) does not contain oxygen; and that the weight of the water collected after burning inflammable and dephlogisticated airs is not equal to that of the airs consumed. It was Priestley's opinion that finery cinder consisted of water and iron deprived of phlogiston.

Maclean stated that, "the same substance is formed by exposing iron to the steam of water, by burning iron in oxygen gas, and by heating iron filings mixed with red oxide of mercury."

That the doctrine of phlogiston was not without difficulties was expressed by Priestley in the following words: "The phlogistic theory is not without its difficulties. The chief of them is that we are not able to ascertain the weight of phlogiston, or indeed that of the oxygenous principle. But neither do any of us pretend to have weighed *light*, or the element of *heat*, though we do not doubt but that they are properly substances, capable, by their addition, or subtraction, of making great changes in the properties of bodies, and of being transmitted from one substance to another."

Dr. Maclean concluded his lectures as follows:

> From the view which has been given of the different explanations of the phenomena of combustion it appears, that Becher's is incomplete; Stahl's though ingenious, is defective; the antiphlogistic is simple, consistent, and sufficient; while Dr. Priestley's, resembling Stahl's but in name, is complicated, contradictory, and inadequate. You doubtless therefore will be inclined to prefer the antiphlogistic doctrine. Indeed, you may adopt it with safety; for from being a plain relation of facts, it is founded on no ideal principle, on no creature of the imagination; it is propped by no vague supposition, by no random conjecture; it is dependent upon nothing whose existence cannot actually be demonstrated; whose properties cannot be submitted to the most vigorous examination; and whose quantity cannot be determined by the tests of weight and measure.

Permanent Potash Supply in New Jersey Greensand. A thousand year's supply of potash for the American farmer, independence in the future from European supplies and the establishment of a new great industry in the United States are all possible as a result of a new process for making potassium sulfate from the great quantities of greensand found in New Jersey, Delaware and Maryland, Dr. J. W. Turrentine, C. W. Whittaker, and E. J. Fox, soil chemists of the U. S. Bureau of Soils, told the American Chemical Society at Los Angeles.

The process has been made economically possible by the manufacture of valuable materials such as alum, alumina, ochers, and glaucosil, a new earthy absorbent, as by-products. The new process is being demonstrated in the laboratories of the Electro Company at Odessa, Delaware. The method consists in extracting the raw material with sulfuric acid. The greensand deposits, which are practically at the surface, can be worked with steam shovels, and Dr. Turrentine said that they are ideally located with respect to water or rail transportation, labor supplies and markets.—*Science Service*

STUDY OF INDUSTRIAL CHEMISTRY BY THE UNIT PLANT RESEARCH DEVELOPMENT METHOD

FRANK C. VILBRANDT, UNIVERSITY OF NORTH CAROLINA, CHAPEL HILL, N. C.

Before considering the study of industrial chemistry by the unit plant research method as carried out in the Department of Chemistry, School of Applied Science of the University of North Carolina, it seems necessary to give a brief statement of the conditions that confront the students in the chemical courses at the university.

PLAN OF RESEARCH DEVELOPMENT METHOD
PLANT RESEARCH DEVELOPMENT TOPICS
PROJECTS STUDIED

Gas Plant Problem
Heat Balance of Power Plant
Laundry Certification
Mercerization
Rosin Varnishes
Tanning of Leather
Utilization of Wood Ashes
Pigment Manufacture
Electrolysis of Salt
Arsenical Insecticides
Organic Chemicals

The University of North Carolina is situated in Chapel Hill, N. C., in the central part of the state, far removed from any chemical industries of importance. The chemical industries that are located in the state are exceedingly small and widely scattered, which condition forces the class to spend most of the time in travel when inspection trips are taken. Occasional trips are made to those plants within a radius of one hundred miles of the university. To make up for this lack of contact with the big industries, a weekly program of industrial moving picture films is maintained at which attendance is required. These films are obtained through the coöperation of the United States Bureau of Mines and the industries. A series of seventeen filmed industries was exhibited to the class during the past year.

Coöperative work with several of the larger industries is being carried on by sending the members of the Junior Class of the Department of Chemistry out into factory or operative work during the summer months. This method of training seems to be the only feasible one for the present although it does not offer the opportunities and advantages of such systems as those of Harvard, the Massachusetts Institute of Technology, or Cincinnati. At present only two out-of-town chemical plants in the state have offered coöperation in this plan.

In addition to the above, the laboratory course in industrial chemistry has been presented by such methods as to bring out the applications of the fundamental chemical concepts learned in undergraduate studies. Plant research development methods are studied in the laboratories and also in available industrial plants on the campus. Several nearby industrial plants are to be included in this project within the next year.

Plan of Research Development Method

The plan, in brief, consists in plant development investigations by the class which has been divided up into groups under a student foreman for each individual investigation.

At the beginning of each session of the school year the class is organized into as many groups as there are members in the class, each group assigned to a special development project under one of the members of the class, who acts as foreman of the group, the other members of the class being directed in their work by this man.

Each member of the class becomes thoroughly acquainted with the individual project of which he is foreman, through consultation of the literature, by plant visits or by correspondence. The next step lies in the planning and organizing of laboratory or plant work and in assigning work to his workmen. After the plan of study has been submitted to the instructor for approval for presentation to the class, the foreman presents to the class in conference his project and the method of attack with written detailed instructions for each member of the class. The problem is then thrown open for discussion to enable the men to ask questions about their assignments and to give the foreman an opportunity to clarify any details or to explain in what manner he expects to conduct the work.

The class is then taken into the laboratory or plant by the instructor and the foreman in charge. The foreman is responsible for all the equipment to be used, for the collection of all apparatus and materials and for the maintenance of order, discipline and attendance on the work. At the end of each week the laborers hand in a written report of all work accomplished within that time. The foreman compiles the data so obtained and makes an oral report to the class in conference, together with a written report to the instructor. After the completion of a project the data are compiled and tabulated and presented on the blackboard to the class for study and analysis. Considerable time is consumed in this last conference on the project to enable each member of the class to express his opinion on the problem and to draw his own conclusions from the data given.

Following this conference the foreman of the completed project writes a complete prospectus for a plant for manufacturing the product or products according to the best practice as determined from the data obtained by his workmen. This prospectus contains plant plans and elevations, detailed specifications of equipment and materials, estimated costs, proposals for location of the plant, operation details and instructions and a discussion of the present, past, and possible future of the market in connection with the product he proposes to manufacture. This final write-up concludes his foremanship status; he then becomes a laborer for the next foreman in the class.

The priority of projects or problems investigated is agreed upon in conference by the members of the class. Often as many as three or four projects may be running at the same time, but one major project is being pushed, the others being straggling experimentation which could not be finished before for various reasons.

Plant Research Development Topics

The problems assigned in this foremanship plan include some of the simpler, known plant processes or problems that can be carried out in the laboratory. These projects are selected so as to include practice in and provide efficiency studies of the fundamental operations used in chemical plants, such as filtration, evaporation, drying, calcining, grinding, sedimentation, decantation, elutriation, crystallization, extraction, chlorination, etc. Oft-times a project may include several of the above operations, but the selections are made so that there is but one major operation.

The problems are not stereotyped, each foreman being required to work out his own plan and to show his own individuality in the organization of the class. Where projects have been given several years in succession, the instructor directs the foreman to make his study along lines different from those previously submitted on the same project. No attempt has been made to develop research data for publication from the results of these laboratory studies, the emphasis being directed toward planning, organizing, and directing of work, together with the analyzing of data for the formulation of conclusions.

This list of projects studied during the last few years includes many simple investigations and some of practical importance. The gas plant of the Department of Chemistry, the steam power plant of the University, and the Model Laundry of the University, are the only outside plants that have been used for industrial chemistry laboratory study up to the present time, the remaining projects being laboratory processes carried out in our industrial chemical laboratory.

Projects Studied

Gas Plant Problem. The gasoline gas plant of the Department of Chemistry is utilized by one member of the class for study. Instructions in handling of equipment, the use of the Orsat apparatus in the analysis of gas mixtures, and the determination of the heating value are given by the foreman to his workman. The effect of changing the composition of the gas, the operation of gas machines and the piping systems are then studied. The pressure drops and flow of gases along the distribution and service lines are measured. The class then designs a gas distribution system for supplying definite demands for gas at different localities.

Heat Balance of Power Plant. The power plant of the University is turned over to the class during the winter season for a complete heat balance study. The regular engineering force of the plant coöperates with the class by supplying the laborers for the heavy work. The class is kept in attendance on this problem for twenty-four consecutive hours. The flue gas and coal are analyzed by the group, while the coal haulage, firing, cleaning of flues and cleaning of grates are left to the regular boiler room

force. Operation data on boiler capacities and all steam and water measurements are collected by the foreman and sub-foreman of the project. Several changes in the operation of the plant as a result of this co-operative work has resulted in the saving of fuel in this boiler room.

Laundry Certification. The Model Laundry operated by the University for the students and the village of Chapel Hill is turned over for one day to the class for a study on operations, raw materials, dirty laundry linens to be washed and the action of washroom operations on the selected pieces of fabrics such as silks, artificial and natural, cottons, woolens, and unions of all types. Microscopic and tensile strength studies are made of the material during the entire run of the fabric through the washroom, then again tested after a full week's laundrying under the foreman's supervision. Quantitative data on all materials used and on the operations together with labor involved are used for making a cost analysis of the operation of such a plant.

Mercerization. Piece goods mercerization with both acids and alkalis is conducted as a laboratory project, emphasis being placed on studying the effect of temperature, concentrations, reagents, quality of cloth, tensions of cloth and washing conditions. Comparisons are made on the cost of operating a plant and the cost of equipment and production of the different processes of mercerization that have been found by the class to give the most satisfactory results, in order to determine which process is the more practical.

Rosin Varnishes. Cost analysis and quality tests of various mixtures of rosin, oil and spirit varnishes are emphasized in this project, although conditions of manufacture and raw materials are not lost sight of. Panel tests are made periodically of the varnish samples, the panels being exposed to weather, to sunlight under glass, to laboratory fumes and to protected indoor exposures. This project is started early in the session to enable as long a time as possible to elapse between the first exposure of the panels and the final dismissal of the class.

Tanning of Leather. Although this project borders on the undesirable and brings forth much protest at its inception, it serves well for bringing home to the student an insight into conditions under which some men must work. The foreman of this group is selected for his ability to handle delicate situations and also for his forcefulness in prosecuting a problem. Fresh hides are obtained from the local butchers and turned over to the students to carry through the processes required to prepare the hide for the tan bath. Conditions of tan bath and tan are varied to enable the students to observe the influence of various factors in tanning.

Utilization of Wood Ashes. With this comparatively inexpensive raw material, semi-plant operations can be conducted, enabling the students to observe the influence of time of lixiviation and temperature of water on

yield, quality of product and cost of production. Several types of by-products are made from the potash recovered and the cost data on production of these are also determined.

Pigment Manufacture. Small quantity pigment manufacture is carried out on green, blue and yellow chrome pigments. Separate and simultaneous precipitations of pigments are made and the effects of time, temperature, concentration and rate of precipitation are studied. The pigments thus made are ground in linseed oil in a Kent paint mill and tested out on service panels. Cost data of production are also emphasized in this project.

Electrolysis of Salt. Electrolysis of brine is conducted in a large cell erected by the members of the class and the effects of the temperature, concentration, and rate of flow of brine, together with crystallization and evaporation data on production of caustic soda are closely observed.

Arsenical Insecticides. This project has a decided local appeal. Calcium arsenate is prepared under different conditions of temperature, concentration, rate of precipitation, and raw materials. The cost of production of the different products is determined for comparison.

Organic Chemicals. Several organic chemicals have been prepared because of specific interests certain students have had in them. Standard preparation formulae are used as a basis for study, the conditions assigned to the students consisting of variations on these formulae. The project enables students to determine the effect of changing conditions on the quality and yield of the chemical and to determine the costs of production.

It is hoped that other and more interesting projects may be added in the future and that additional outside plants can be added to the list for co-operative work with the class in industrial chemistry. Lack of suitable equipment for some of the studies has handicapped the work to some extent but progress is being made each year in building up the course.

Light-Bearing Ether Compressible, Says Physicist. The ether which is believed to pervade space and carry light may be compressible, according to the ideas of Dr. Ludwik Silberstein, of the Eastman Kodak Company's research laboratory. In a recent statement to *Science Service*, Prof. Albert Einstein, of relativity fame, differed with Dr. Silberstein's views, saying that the Stokes theory of the ether, on which Dr. Silberstein's is based, would not explain the astronomical aberrations. It was, he said, based on a mistaken idea that the velocity of the ether movement was deducible from a potential.

"Against Prof. Einstein's contention," says Dr. Silberstein, "a velocity potential of the ether motion as required for the Stokes theory of aberration becomes possible at once if the ether is assumed to be compressible. This was originally suggested by Planck, and was adopted by H. A. Lorentz, who based on it a perfectly satisfactory theory of aberration. All other phenomena then known were also covered by this theory. Whether the new experimental findings by Prof. Miller will necessitate a further modification remains to be seen."—*Science Service*

DYES AS MICROCHEMICAL REAGENTS

H. J. CONN, AGRICULTURAL EXPERIMENT STATION, GENEVA, N. Y.

Until recently histology and microchemistry were thought to be two distinctly different subjects. The histologist, with the technique and viewpoint of the biologist, prepares delicate sections of various biological material and examines it under the microscope, colored to be sure, with one or more of a long series of available dyes, and studies the biological structures present. The microchemist, with the technique and viewpoint of the chemist, examines similar material under the microscope, treated with various reagents of known chemical action, and from his observations draws conclusions as to the chemical nature of the substance examined. We are now beginning to wonder if the difference between these two branches of science does not lie in the technique and viewpoint of the student rather than in the methods or the subjects considered.

Both the microchemist and the histologist study the action of chemical compounds on substances or structures visible under the microscope; the difference is that the microchemist uses the chemical compounds in question as chemical reagents, while the histologist uses his as dyes to color the microsopic structures and thus to increase their visibility. A few examples will make this clearer.

Suppose the biologist has a section or series of sections prepared from tissue in which he wishes to bring out the nuclei of the individual cells. To do so he stains the material, after proper preliminary treatment, with some one of a series of dyes which he knows as nuclear stains. These nuclear stains are without exception basic dyes, but the biologist may possibly not know them by that name. If he does, he assumes that the name means that they are basic in reaction like caustic potash or ammonium hydroxide. He does know from experience, however, that that portion of the animal or plant cell which he calls the nucleus has a special affinity for dyes of this class. Sometimes, to be sure, a dye of this sort will stain the cytoplasm outside of the nucleus to some extent; but if so, the color imparted may be easily washed out with some solvent such as alcohol or possibly even water. He also knows that certain bodies inside the nucleus, which he calls chromatin granules (simply because of their special affinity for dyes), take these basic dyes to an even greater extent than the rest of the nucleus and that, with the proper staining technique and sufficient length of subsequent decolorization with alcohol, they may be made to stand out plainly from the surrounding parts of the nucleus. Now, to the biologist, the various bodies and granules thus brought to his vision are biological structures, that is, parts of the machinery of life. It seldom occurs to him that he is actually recording observations in microchemistry and that if he only knew exactly the chemical behavior of his

reagent (that is the dye which he uses) he would have some knowledge as to the chemical nature of the cell contents.

In some of these histological procedures the biologist finds that a very skillful technique is necessary in order to obtain the proper differentiation of the different bodies within the cell; in other words the microchemical reactions taking place are very complex and difficult to control. The Flemming triple stain is a very good example of one of the most complicated. By this method sections are first stained in a strong solution of safranin, which is then washed out as far as possible by treatment with alcohol; they are then stained for two or three hours in a methyl violet solution followed by a washing in distilled water; then treated with a third dye, orange G, in strong solution; finally decolorized once more in alcohol. By this procedure the chromatin granules stain one color, the rest of the nucleus another, while the cytoplasm outside of the nucleus stains a different color; but the whole process must be very carefully controlled and only the trained histologist can count on satisfactory results. There are undoubtedly various reactions taking place between the acidic orange G and the two basic dyes employed; but the reactions are certainly very complex and to what extent the staining is produced by chemical means and to what extent by physical is hard to say. Such a procedure as this, however, comes very close to microchemistry except that it is carried on with poorly understood reagents whose reactions are largely unknown.

As another example of the delicate chemical phenomena involved in staining, the so-called blood stains may well be mentioned. These stains are ordinarily chemical combinations of eosin, yellowish with a mixture of various thionins. In preparing them one ordinarily starts with methylene blue, that is tetra-methyl thionin. This is treated with alkali in some specified way so as to break it down to some extent, and a product known as "polychrome methylene blue" is produced. This product owes its polychrome properties to the presence of lower homologs, such as trimethyl thionin and the two di-methyl thionins. It has recently been shown just which of these products are necessary in the blood stains and it is proposed to prepare definite mixtures of the known dyes instead of the indefinite mixture present in polychrome methylene blue. However, this mixture is prepared, it is then combined with eosin; and as the eosinates of the thionin dyes are insoluble in water, a precipitation slowly takes place. The precipitate is the blood stain. It is dissolved in methyl alcohol for use. Now, alcoholic solutions of dyes do not have much staining power, so the usual method of use is to apply a drop of the alcoholic solution to the blood film and then to dilute with water. Considering that the blood stain is an alcoholic solution of various compounds which are insoluble in water but which are fairly readily dissociated, a chemist can easily realize the wealth of chemical reactions which may be going on in

this little drop of dye, on top of the film of dried blood in which water and alcohol are being mixed. The biologist certainly seldom realizes it. All he knows is that if the procedure is carried on properly, red blood cells acquire one color, white blood cells another, with their respective nuclei still differently colored, while protozoan parasites, if present in the blood, have characteristic staining properties of their own.

Such illustrations as these show to what extent the biologist is using complicated chemical reactions in his microscopic technique—so complicated in fact as to be unintelligible chemically. To bridge the gap between histology and microchemistry, these reactions must be made intelligible. The first step in this direction was recently made by the German histologist, Unna. He points out the need of harmonizing chemical and histological investigations and proposes a method of doing this which he calls chromolysis. The technique, as he has developed it, is complicated; but it is briefly as follows: To select a dye, or a mixture of dyes, either acid or basic, which bring out some intercellular structure whose chemistry it is desired to learn: then to submit the sections to the action of various solvents, beginning with simple cold water, then proceeding to hot water, and from that to the more powerful solvent, but using only those whose effects on proteins, lipoids or carbohydrates are known to the chemist; then to stain the sections with the staining fluid selected; and finally to determine by microscopic examination which solvents have removed the substance under investigation.

By such methods as these, Unna hopes to make considerable progress in the microchemistry of the biological cell; and it will be readily seen that once the gap between chemistry and histology is bridged, progress will become constantly more and more rapid. As soon as reasonable hypotheses are obtained as to the chemical nature of the various intercellular bodies in any one particular type of tissue, it will be possible to figure out the affinities of the different dyes now used in histology for the different chemical compounds thus recognized; and then by using the same stains on other tissue the information thus obtained can be applied toward learning the chemistry of other microscopic structures. In other words stains will become chemical reagents instead of merely dyes for making microscopic structures visible. In this way it is hoped that chemistry and histology, working together, may solve some of the obscure problems as to the nature of the biological cell and its contents.

MOURNFUL NUMBERS

LOUIS C. JORDY, SYRACUSE UNIVERSITY, SYRACUSE, N. Y.

Again it is percentage which threatens disaster to the student. Should he fail in chemistry not because of his inability to analyze the chemical situation but because he lacks even an elementary knowledge of arithmetic? Or should a prerequisite course in mathematics be required for the chemistry course? One is inclined to agree with the writer of this article that a freshman needs more plain arithmetic even at the expense of such subjects as atomic structure, radioactivity and kindred topics.

In the first two general written quizzes given to our freshman chemistry class, a striking feature of the papers was the large number of errors in solving problems—errors in the fundamental processes of arithmetic, not in analysis of the situation. It was the unanimous opinion that the class in general chemistry was sadly deficient in fundamental mathematical training, particularly in the use of decimals, percentage, and proportions. It was thought worth while to get some quantitative information as to the extent of the deficiency.

It is customary to begin nearly every meeting of each recitation section with a short written quiz, covering some of the high spots of the day's assignment. A set of three problems was prepared, to be presented as a routine short quiz to all the sections, concealing the fact that the test was simply one of mathematical ability.

The three problems submitted, with 20 to 22 minutes allowed for solving, were as follows:

(1) In a laboratory experiment on "water of hydration," the following data were obtained: An empty crucible was just balanced by 10 grams and 40 milligrams placed on the opposite pan of the balance. When a sample of a hydrate was placed in the crucible, 11.80 grams were needed to balance it exactly. Later, after repeated heating, the crucible and contents were exactly balanced by 11 grams and 764.8 milligrams, and further heating failed to make any change. Calculate the percentage of water of hydration in the original sample.

(2) By Henry's Law, the weight of a gas that may be dissolved in a liquid increases in direct proportion to the pressure applied. At 0°C. and 760-mm. pressure, 1 liter of water will dissolve 0.0291 gm. of nitrogen gas. If I wished to dissolve 0.1067 gm. of nitrogen in a liter of water at 0°C., what pressure would I need to apply?

(3) The 3% hydrogen peroxide solution used in our laboratory is made by properly diluting "Superoxol," which is a 30% solution of hydrogen peroxide. If a bottle contains 1800 grams of "Superoxol," what weight of our laboratory kind of H_2O_2 solution may be made from it?

The wording of the problems was made as simple as possible, to avoid any charge of "catch questions," and it will be noted that no tax was laid on the students' memory of laws involved. All three questions dealt ostensibly with matters of the students' own recent experience, in laboratory and lecture, but were, as a matter of fact, merely some simple and thinly

camouflaged seventh-grade arithmetic. The second problem, in particular, as stated should be capable of solution by students with no knowledge of chemistry. Results of the test, however, more than justified our most pessimistic forebodings.

The papers were first grouped on the basis of the number of questions answered; no attention was paid to unfinished problems, whether or not correct so far as they went. On this basis it was found that of the 471 students who handed in papers, $2^1/_2\%$ had not succeeded in 20 minutes in getting anything that might be construed as an answer to a single question; 13.5% answered one problem; 26.5% answered two; 57.5% answered all three. Fifty-one individuals, not quite 11% of the total, completed all the problems and had absolutely correct answers.

A statement of results for each problem separately will show better the decidedly unsatisfactory performance of the class:

NUMBER OF ANSWERS CORRECT AND INCORRECT

	Correct	Incorrect	Total
First problem	168 (38%)	274 (62%)	442
Second problem	161 (43.75%)	207 (56.25%)	368
Third problem	188 (58.4%)	134 (41.6%)	322

It will be seen that only in the case of the absurdly simple third problem did a majority of those who got an answer get the correct one; in the other two instances approximately six out of every ten had made some slip. The nature of these slips and their relative frequency next came in for examination.

Possible errors appeared to be of four types: (1) mistakes in addition, multiplication, etc.; (2) errors in decimals; (3) errors in percentage, apart from those in decimals, procedures which would indicate a general failure to grasp the meaning and use of percentage; (4) inability to handle simple proportion. All three problems, of course, included the first two possibilities, plus one or the other of the last two. The synopsis of our comedy of errors follows:

TYPE OF MISTAKE MADE

Problem	Arithmetical error	One decimal	Two decimals	Three decimals	Per cent	Proportion
1	44	167	24	2	92	..
2	135	62	..	.	..	30
3	16	..	..	.	27	95

It is worth noting that in every case the total number of mistakes made exceeded the number of incorrect answers turned in, showing that a considerable group of students was not content with a single error, but insisted on good measure. In the first problem two men registered a perfect score by making three separate errors in decimals—all that the nature of the problem could possibly allow.

The conclusion is discouragingly obvious: of our class in freshman chem-

istry, recruited from 270 different secondary schools in 18 of our states and 4 foreign countries, apparently less than half can be trusted to solve correctly a simple chemical problem—not because of failure to grasp the scientific principles involved, but because they do not yet know the multiplication tables, nor the decimal system, nor that the English translation of "per cent" is "per hundred parts." Here is an excellent chance to draw the fire of the mathematics pedagogs by a judiciously worded inquiry as to the cause of the putrefaction in Denmark; but, to borrow again a much-borrowed phrase, this is a condition which confronts us, not a theory. Further, the condition shows signs of persisting for some little time; therefore it might be interesting to consider one or two of the questions that will suggest themselves to the chemistry teacher.

Should we allow any student to pass in chemistry who is consistently unable to do simple chemical calculations? As our course is constituted at present, ability to solve problems counts for not over 25% of the final grade; and it is therefore at least a possibility that a student might attain a passing grade without ever having solved a problem unaided. Giving part credit on problems where the principle is right but the answer wrong increases this possibility. We might perhaps show some complacency in passing those who take chemistry only as a cultural course and who do not expect to pursue the subject further; but for those intending to go ahead in the science, passing them in the freshman course means only passing the buck to instructors in advanced courses—who are much less likely to be complacent.

It would seem to be worth considering whether a little time ought not to be devoted at the outset of the first year to a frank review of the simple mathematics required, just as already considerable attention is paid to reviewing the metric system, the gas laws, and certain other laws, definitions and formulae of physics.

The recent tendency seems to have been to make the first-year course in chemistry much more comprehensive, with chapters on colloids, atomic structure, radioactivity and kindred topics. These are all excellent things for a freshman to know, but considering the evidence of these tests in plain arithmetic, one has an uncomfortable feeling that the freshman is incapable of knowing them. Millimicrons will not mean much to an individual who doesn't feel quite sure whether 0.001 should be read "one-hundredth" or "one ten-thousandth;" and a student who has only a vague notion of simple arithmetical proportion may be expected to have trouble understanding the elementary weight relations existing between the atoms. If, added to this, he is untrained in the meaning of graphs and knows nothing of the word "function" used in the mathematical sense, it need not seem strange if his first conception of our periodic table is of something connected with punctuation or laboratory furniture rather than with the

fundamental relations of the elements. Considering such points as these, along with the fact that in many cases this student is not quite certain whether 6 times 8 are 52 or 44—how much are we justified in thinking he will get out of a quantum theory, or an octet arrangement of electronic shells, or a concept of numerous electrons whizzing merrily about in orbits of varying amplitudes, eccentricities and angles with each other?

The writer was impressed recently with a statement made by a teacher of advanced courses, a man of long experience, who was commenting on the quality of material being turned over to him nowadays from the elementary course. He said: "If the teachers of freshmen chemistry would spend the entire year on the one subject of oxygen, and genuinely *teach* that subject so that the students really knew the fundamentals about oxygen at the end of the course, the results would be as satisfactory, culturally and practically, as under the present system of skimming over dozens of topics and not really getting any of them." He was speaking more or less figuratively, of course, and was not referring to those unusually good students who serve to make the teacher's existence endurable. But it certainly is a question whether the effort of late has not been along the line of increasing surface adsorption at the expense of permanent assimilation. Those who heard Prof. Donnan comment on the situation at the Ithaca meeting last fall will recall his amusing description of how the present-day freshman discourses glibly and superficially on radium emanation, X-ray spectra and like topics, but crashes ignominiously when called upon to explain why we write hydrogen H_2.

We have seen the text-books growing steadily thicker in recent years, rising from four hundred to five and now even six hundred or more pages. In the light of results from this little test in arithmetic, one pessimistic instructor suggests that we formulate a new law:

"The 'thickness' of chemistry students increases directly as the square of the average thickness of chemistry text-books."

WINNERS OF AMERICAN CHEMICAL SOCIETY'S PRIZE ESSAY CONTEST 1924–1925

Miss Shirley Cordill, (I. Newman Manual Training School), 455 Walnut Street, New Orleans, La.

Mr. Henry Shipworth Singletary, Jr., (Port Arthur High School), 314 Beaumont Avenue, Port Arthur, Tex.

Miss Ruth Jamieson, (Whittier Union High School, Whittier, Calif.), Box 674, Rivera, Calif.

Mr. Roger S. Makepeace, (Phillips Academy, Andover, Mass.), 161 Prospect Street, Waterbury, Conn.

Miss Marion Honke, (St. Angela Academy, Carroll, Iowa), Butte, Neb.

Miss Jane Summers, (Ensley High School), 1300 Pike Ave., Ensley, Ala.

A STUDY OF PUPIL ERRORS IN CHEMISTRY

J. C. BENNETT, EAST HIGH SCHOOL, CLEVELAND, OHIO

The success of any process of education involving teachers and taught is determined by the sum of two factors—the receptivity of the pupil and the effectiveness of the instructor. It is incumbent upon the teacher to maintain that sum at as high and constant a level as possible. A careful study of pupil errors reveals the points at which more intensive instruction must compensate deficiencies in learning ability.

Standardized chemistry tests, such as the Powers Tests, the Gerry Tests, and others, are of great value to chemistry teachers to show how one group of pupils compares with another as to mastery of certain items now commonly taught in our chemistry courses. The usefulness of these tests may, however, be extended tremendously, if teachers will study the *kinds* of errors pupils make in answering questions based on the common subject matter of high-school chemistry.

Studies of pupil-errors—a fertile field—should lead to improvement in chemistry teaching. Improvement in presentation of subject matter of high-school chemistry is at least greatly to be desired, if not imperative. A few quotations from Dr. Powers,[1] "A Diagnostic Study of the Subject Matter of High-School Chemistry" will show why the word *imperative* is perhaps not out of place in this connection. "The task set for high-school students of chemistry is beyond their accomplishment." "A large proportion of text-book material means little or nothing to 50% or more of the students who have studied the texts for a year." "Neither mastery of principles nor a knowledge of facts is acquired by any considerable number of chemistry students."

To help remedy the situation—and none of us teach the subject *too* well—we must find out what pupils learn in chemistry and how they learn it, what mistakes they make and how they can be helped to avoid making these mistakes.

Interest in this matter led to a study of pupil-errors in chemistry in the classes at East High School, Cleveland, during the first semester of the school year, 1924, with two divisions in 12 B Chemistry, numbering about 55 boys and girls. The intelligence quotients (Terman Group Test) ranged from 78 to 124, the median being 112. Intelligence quotients of 6 pupils were less than 97 and 8 were 120 or higher. The study was continued in the second semester of the school year with the same class, now 12 A, and was re-commenced with a new class of 12 B's consisting of 32 pupils ranging in intelligence from 86 to 125, with a median of 105. Intelligence quotients of 5 pupils were below 97 and 2 were 120 or above.

The types of questions submitted to the pupils were selected rather for the definiteness of the answers which the teacher could expect than for the suitableness of the subject matter, although all the questions dealt with subject matter treated in the usual elementary text.

[1] Teachers College Contributions to Education, No. 149.

The questions were of six types, as follows:

Type 1. Problems on the volumetric and the gravimetric composition of water.
Type 2. The law of multiple proportion and problems based on it.
Type 3. Gas-volume problems.
Type 4. Word equations.
Type 5. Formula equations.
Type 6. Formulae.

A few examples of the kind of questions asked under Type 1 are as follows:

(*a*) 10 g. oxygen unite with how much hydrogen?
(*b*) 5 cu. ft. hydrogen will require how much oxygen in burning?
(*c*) How much water forms in (*a*)?
(*d*) How much steam forms in (*b*)?
(*e*) If 9 g. steam are decomposed, how much hydrogen forms?

TABLE I

SHOWING PERCENTAGE OF PUPILS GIVING INCORRECT ANSWERS ON PROBLEMS OF TYPE 1. (OCT. 6–MAR. 26)

Attempts	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Av.
Weight problems, metric	45	20	21	2	4	3	9*	8	6	12	4	2	2	4	10
Weight problems, English	35	24	23	7	2	25*	12	12	..	..	.	.	.	.	17
Weight of product	59	22	27	10	4	5	13*	17	10	12	2	4	.	.	15
Volume problems, metric	45	20	16	2	0	4	4	8*	4	8	6	.	.	.	11
Volume problems, English	37	25	25	0	0	6*	8	6	4	..	.	.	.	.	12
Volume of product	46	5	5	2	10*	12	4	4	6	..	.	.	.	.	10
Decomposition problems, weight	42	12	27	18	34	26	13	22	26	8	.	.	.	.	23
Decomposition problems, volume	40	4	2	2	6	12	12	10	7	0	.	.	.	.	9

(FEB. 26–MAR. 26)

Attempts	Feb. 27	Mar. 10	Mar. 11		Mar. 20	Mar. 26	Mar. 27	Av.
Weight, metric	..	23	27	28	11	..	..	22
Weight, English	58	29	20	3	..	40	13	27
Weight, product, metric	..	..	37	..	11	..	..	24
Weight, product, English	..	..	..	7	..	40	17	21
Volume, metric	..	36	27	11	7	..	..	20
Volume, English	45	42	13	11	..	13	13	23
Volume, product, metric	..	..	50	17	7	..	..	25
Volume, product, English	..	..	40	14	..	13	10	19
Decomposition, weight	..	..	..	..	11	70	30	37
Decomposition, volume	..	..	..	..	18	23	23	21

* Test taken after 16-day vacation.

The data for this study were obtained from the written work of the pupils. Test items of each type were repeated. In many cases, there were frequent repetitions. For example, the collection of data on word equations was begun on October 17th and the test was repeated 10 times during the semester. Again, these tests were given to the beginners in the second semester, making a total of 13 times. However, the test was not always on the same word equations, as the tables will show.

A study of the errors on problems of Type 1 shows that:

(1) There is apparently little difference in difficulty of problems in English and in metric units.

(2) There is seemingly little difference in difficulty of problems dealing with weight and with volume of combining elements and of the products formed.

(3) Weight problems dealing with decomposition of water into hydrogen and oxygen are apparently the most difficult problems of this type.

An analysis of the kinds of errors made on problems of Type 1 brings out the following fact: The inability of pupils in general to decide whether to multiply or to divide by 2 or by 8 or by 9, in solving these problems shows that the basic facts underlying the solution of these problems are not mastered by many of the pupils.

Perhaps better results would be obtained by presenting the weight problems first, and, after these problems are mastered, presenting volume problems, instead of presenting weight and volume problems simultaneously, which is the practice at present.

Under Type 2, examples of the following kind were submitted to the pupils: A compound of carbon and hydrogen contains 6 weights of carbon to 2 of hydrogen. A second compound contains 12 weights of carbon to 2 of hydrogen. Considering a fixed weight of carbon, what is the ratio between the weights of hydrogen?

TABLE II

SHOWING PERCENTAGE OF PUPILS WHO STATED THE LAW INCORRECTLY AND THE PERCENTAGE OF PUPILS WHO GAVE INCORRECT ANSWERS TO PROBLEMS BASED ON THIS LAW. (OCT.–FEB.)

Attempts	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Law	54	41	40	..	28	.	..	..	19	..	12	..	0	4
Problem	..	..	..	49	..	8	40	30	..	20	..	51	.	.

Attempts	Mar. 11	Mar. 13	Mar. 17	Mar. 18	Mar. 20	Mar. 27
Law	63	52	..	..	..	..
Problem, 12B	..	..	48	41	50	63
Problem 12A	..	..	..	23	23	11

Table II indicates that it is only with difficulty that many pupils learn to state the law of multiple proportion. That they then understand the law is an assumption not verified by the data on ability to solve problems

based on this law. It must be admitted that the law presents to the pupil difficulties in comprehension. Certain it is that we must develop better methods of presentation, if this law is to remain a part of the chemistry course.

An analysis of the errors made in the statement of the law shows that the one point of greatest difficulty is in understanding the nature of the ratio with which the law deals. The fact needs frequent repetition that the ratio is between different weights of B, and not between weights of A and B.

The text-books in common use give few illustrations of the law, and no problems. It is possible, perhaps, to improve the presentation of this topic by giving many more problems based on the law and by presenting them in carefully graded order.

Under Type 3 an example of the kind of questions submitted to pupils, on gas volumes is as follows: A gas measures 2 cu. ft. at 21°C. and 780 mm. Find its volume at a temperature of 0°C. and a pressure of 780 mm.

TABLE III

SHOWING NUMBER OF CASES IN WHICH THE TEMPERATURE FACTOR AND THE PRESSURE FACTOR WERE STATED INCORRECTLY, IN PROBLEMS OF TYPE 3 (GAS PROBLEMS) (OCT.–FEB.)

Attempts	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Temperature factor	22	14	5	12	10	10	6	9	6	6	2	6	9	117
Pressure factor	20	16	13	16	8	14	10	14	10	8	8	11	4	152

Attempts	Mar. 2	Mar. 26	Mar. 27	Total
Temperature factor	7	17	8	32
Pressure factor	6	6	3	15

In Table III, it will be noted that in the first 13 trials, the number of errors on the temperature factor was 117, while on the pressure factor the number of errors was 152 (a ratio of about 2:3). This would indicate a greater difficulty in learning with respect to the pressure factor than with respect to the temperature factor. According to the testimony of the pupils, the difficulty in remembering to *invert* the fraction dealing with pressure accounts for the difficulty connected with the pressure factor.

The last of these 13 observations was made January 27. After a lapse of more than a month, beginning March 2 there were repeated, at intervals, problems of the same type, for the purpose of showing to what extent this material had been retained. After four repetitions, the ratio of errors in temperature factor to pressure factor—such is the perversity of human nature—was now 2:1 whereas it at first was 2:3. A study of the nature of the errors in the latter portion of the investigation shows that a few pupils inverted the temperature factor, some neglected to add 273 to numerator and denominator, and some forgot the exact number to be added, and used either 373 or 237.

As to questions on Type 4, word equations similar to the following were submitted:

(*a*) Potassium chlorate ⟶ potassium chloride + oxygen

(*b*) Sodium + water ⟶ sodium hydroxide + hydrogen.

TABLE IV

SHOWING PERCENTAGE OF PUPILS RECORDING INCORRECT ANSWERS TO QUESTIONS OF TYPE 4 (WORD EQUATIONS) (OCT. 17–FEB. 24)

Attempts	Oct. 17	29	30	Nov. 4	6	14	17	Dec. 17	Jan. 7	27	Feb. 24	Av.	Rank
$H_2 + CuO$	18	12	0	2	..	0	..	..	..	.	2	6	3
$Na + H_2O$	49	11	5	9	..	7	..	..	..	.	6	14	1
$KClO_3$	33	27	20	9	..	9	..	..	..	.	14	19	.
$H_2SO_4 + Zn$	18	16	5	5	..	..	..	..	..	.	0	9	2
HgO	16	14	0	2	..	..	..	..	..	0	0	5	4
$HCl + Mg$	..	..	..	..	17	..	..	4	10	0	2	7	4
$HCl + Fe$	..	..	..	29	..	28	..	22	..	0	2	16	1
$H_2SO_4 + Fe$	..	..	..	9	..	..	..	6	8	4	2	6	5
$P + O_2$	..	..	..	20	..	..	..	13	6	0	0	8	3
$HCl + Zn$	..	..	..	23	..	13	..	4	..	.	2	10	2
$HCl + Al$	..	..	..	..	7	7	..	6	..	.	0	5	6
H_2O	..	..	..	..	..	..	..	..	2	.	2	2	7

Attempts	Mar. 2	Mar. 3	Mar. 16	Av.	Rank
$H_2 + CuO$	29	16	15	20	3
$Na + H_2O$	42	16	15	34	1
$KClO_3$	10	3	19	11	.
$H_2SO_4 + Zn$	45	19	11	25	2
HgO	3	3	11	6	4
$HCl + Mg$	..	..	15	15	.
$Fe + H_2O$	..	..	24	24	.
H_2O_2	..	..	8	8	.
$HCl + Cu$	..	..	11	11	.
$HCl + Ag$	..	..	15	15	.

Rank in both tables	
$H_2 + CuO$	3
$Na + H_2O$	1
$H_2SO_4 + Zn$	2
HgO	4

In Table IV, the equations are ranked in two groups, according to the dates on which the testing was begun. The fact that the tests given to two beginning classes, one in October, the other in March, show identical results as to order of difficulty in writing word equations is significant. The most difficult in this list is the word equation for the action of sodium on water: the easiest one is that for heating mercuric oxide. The reason for excluding the equation for heating potassium chlorate in the ranking is that a different and easier method for writing this equation was taught the midyear class so that data for the two classes on this item are not comparable.

Analysis of the kinds of errors shows that in the word equation for the action of sodium on water, the most frequent error was in connection with the name of the product sodium hydroxide.

In the equation for the action of sulfuric acid on zinc, the most common

error consisted in naming one of the products zinc sulfide or zinc hydroxide instead of zinc sulfate.

In the equation for the action of hydrogen on hot copper oxide, the common error consisted in naming only one of the two products.

The questions under Type 5 involved writing formula equations for the same reactions for which word equations had been required in Type 4.

TABLE V

SHOWING PERCENTAGE OF PUPILS RECORDING INCORRECT ANSWERS TO QUESTIONS OF TYPE 5 (FORMULA EQUATIONS) (NOV. 17–FEB. 24)

Attempts	Nov. 17	Nov. 19	Nov. 25	Dec. 5	Dec. 8	Feb. 4	Feb. 9	Feb. 24	Av.	Rank
H_2O	27	11	..	..	4	..	..	9	13	7
$Na + H_2O$	64	27	16	16	14	15	..	7	23	$4^1/_2$
$KClO_3$	42	20	..	11	8	..	12	14	18	6
$HCl + Zn$	62	30	13	..	12	..	..	7	25	3
HgO	58	16	..	..	20	..	8	14	23	$4^1/_2$
$Cu + HNO_3$	..	..	..	..	..	..	49	72	61	1
$Hg + HCl$	..	..	..	..	..	..	51	27	39	2

The fact that the equations in Table V are ranked very differently than those in Table IV is due to the fact that writing word equations involves very different mental processes than does writing formula equations.

The most common error in connection with the formula equation for the action of sodium on water was that while the equation was balanced, it was not molecular.

In the formula equation for heating mercuric oxide, the commonest error consisted in writing Mg, instead of Hg, for mercury.

In the formula equation for heating potassium chlorate, the common error consisted in writing three products, potassium, chlorine, and oxygen.

In writing the formula equation for the action of hydrochloric acid on zinc, the common error consisted in writing ZnCl instead of $ZnCl_2$.

In the formula equation for the action between mercury and hydrochloric acid, the most common error consisted in the failure to recognize that there is no action.

In writing the equation for the action between copper and moderately dilute nitric acid, the chief error among a multitude of errors consisted in writing hydrogen as one of the products.

The most difficult of the formula equations was found to be the last-named one: the easiest, the electrolysis of water.

Table VI merely takes the data from Tables IV and V and compares them. The same equations in these two tables, it is true, are ranked differently, for the reason previously stated. However, it may be easily noted that in the case of each equation, the percentage of pupils writing the incorrect formula equation is decidedly higher than the percentage writing the corresponding word equation. This is true even in spite of the fact

that word equations are taught earlier in the course than are formula equations. The foregoing facts may suggest to us that a more extended use of the word equation as an approach to the formula equation may prove to be good psychology in chemistry teaching. Also, an intensive study of

TABLE VI

SHOWING COMPARISON OF DIFFICULTY IN WRITING WORD EQUATIONS AND FORMULA EQUATIONS, INDICATED IN PERCENTAGE OF PUPILS GIVING INCORRECT ANSWERS ON FIRST ATTEMPT AND ON AVERAGE

	Word equations				Formula equations			
	1st attempt	Rank	Av.	Rank	1st attempt	Rank	Av.	Rank
H_2O (Decomposition of water)	2	5	2	5	27	5	13	5
HgO (Heating mercuric oxide)	16	4	5	4	58	3	23	2½
HCl + Zn (Hydrochloric acid and zinc)	23	3	10	3	62	2	25	1
$KClO_3$ (Heating potassium chlorate)	33	2	19	1	42	4	18	4
Na + H_2O (Sodium acting on water)	49	1	14	2	64	1	23	2½

relative difficulty in a list of equations may reveal to us the best order in which to teach equations.

An interesting side-light is thrown on the matter of pupil-errors by Table VII.

TABLE VII

SHOWING NUMBER OF PUPILS MAKING A PERFECT SCORE, ON FIRST TRIAL AND ON EVERY TRIAL (OCT.–FEB.)

Type of problem	1st attempt	Every attempt	No. of attempts
Weight-volume problems	14	7	12
Law of multiple proportion	25	16	8
Example	29	10	6
Gas volume-pressure-temperature	23	9	13
Word equations	19	8	5
Formula equations	9	7	4
Formulae, 45 different ones	6	0*	142

* One pupil made only one error.

Since, for example, in writing the law of multiple proportion, 25 of the 55 pupils made a perfect score in the first trial, and 16 made a perfect score in every trial, repeated 8 times, it means waste in pupils' time and in teachers' effort to get the reluctant or the incapable 37 to learn. Some teachers there are who will maintain—and not without some justice—that here is an argument for the construction of a chemistry course based on individual differences.

Type 6 consisted of formulae.

According to Table VIII, of the 45 formulae presented, possibly the most difficult are those for magnesium acetate, ammonium carbonate, potassium tartrate, and ammonium sulfide.

TABLE VIII

SHOWING PERCENTAGE OF PUPILS WRITING INCORRECT FORMULAS

Attempts	1st	2nd	3rd	4th	5th	Attempts	1st	2nd	3rd	4th	5th
$FeSO_4$	21	0	4	0	..	$Fe(NO_3)_2$	16	4	2	..	..
$Zn(NO_3)_2$	38	12	26*	..	..	$Mg(NO_2)_2$	17	12	4	..	..
Na_3PO_4	64	14	0	4	0	Ag_2S	15	4	8	..	..
$Al(NO_2)_3$	51	17	29*	2	..	Hg_2O	8	12	6	..	..
ZnS	66	17	6	..	..	$Zn(ClO_3)_2$	25	15	10	..	..
Ag_2SO_4	53	4	4	..	..	$FePO_3$	14	10	..	..	..
$FePO_4$	66	0	4	0	0	$Al_2(SO_4)_3$	17	4	..	..	..
$HgCl_2$	15	21	34*	4	..	Fe_2S_3	8	17	..	..	..
$FeCl_2$	19	2	4	2	8	$HgNO_3$	8	4	..	..	..
$NaSO_3$	6	37*	2	4	..	$CuCO_3$	6	14	..	..	..
$Cu_3(PO_4)_2$	21	31*	6	2	..	$Fe(ClO_3)_2$	2	8	..	..	..
K_2CO_3	27	38*	6	0	..	$Fe(ClO_2)_3$	12	12	..	..	..
Al_2S_3	19	27*	2	8	..	H_2SO_4	14	19	..	..	..
Ag_2O	6	29*	0	2	..	$Ca(ClO_4)_2$	15	19	..	..	..
HNO_3	25	32*	2	4	..	$(NH_4)_2CO_3$	49	25	..	..	..
$FeCO_3$	25	31	2	0	..	$K_2C_4H_4O_6$	51	31	..	..	..
$Fe(NO_2)_3$	14	21	6	8	..	$NaClO_2$	12	8	..	..	..
$Mg(C_2H_3O_2)_2$	14	40	29	23	..	Ag_2SO_3	15	4	..	..	..
$Al_2(CO_3)_3$	21	16	0	0	..	$(NH_4)_2S$	48	25	..	..	..
$FeSO_3$	12	10	2	8	..	$Mg(ClO)_2$	23	10	..	..	..
Cu_2O	21	16	4	8	..	$HgClO_3$	14	8	..	..	..
$Fe_2(CO_3)_3$	29	6	2	0	..	$Fe(NO_2)_2$	12	14	..	..	..
$HgSO_4$	12	16	4	8	..						

* Test taken after 16-day vacation.

TABLE IX

SHOWING NUMBER OF ERRORS ON COMPOUND RADICALS

	Name	No. of errors	No. of cases	% incorrect	Rank	% incorrect*	Rank
1.	Sulfate	10	636	2−	15	3.7	9
2.	Sulfite	18	424	4−	$10^1/_2$	..	..
3.	Hyposulfite	17	106	16	2	26	1
4.	Nitrate	14	318	4+	$10^1/_2$	..	..
5.	Nitrite	48	530	9	$4^1/_2$	5.6	8
6.	Hyponitrite	22	212	10	3	7.5	$6^1/_2$
7.	Phosphate	12	742	2−	15	9.4	$4^1/_2$
8.	Phosphite	2	106	2−	15	..	..
9.	Hypochlorite	4	106	4−	$10^1/_2$	11.2	3
10.	Chlorite	3	106	3−	13	..	..
11.	Chlorate	19	265	7+	6	..	..
12.	Perchlorate	6	106	6−	7	7.5	$6^1/_2$
13.	Tartrate	9	106	9−	$4^1/_2$	16	2
14.	Acetate	11	212	5+	8	9.4	$4^1/_2$
15.	Ammonium	42	212	19+	1	1.8	10
16.	Carbonate	28	848	4−	$10^1/_2$	..	..

* Repetition after a lapse of $1^1/_2$ months.

Table IX indicates that perhaps the most difficult of the compound radicals when first presented to the beginner are the ammonium radical (No. 15), and the hyposulfite radical (No. 1). After a lapse of six weeks,

TABLE X

SHOWING NUMBER OF ERRORS IN VALENCE

	Name	No. of errors	No. of cases	% incorrect	Rank in difficulty
1.	Ferrous	60	1166	5	8½
2.	Ferric	63	795	8−	6½
3.	Silver	54	636	9−	4½
4.	Mercuric	36	424	9−	4½
5.	Mercurous	13	265	5−	8½
6.	Oxygen	0	583	0	10
7.	Acetate	39	212	13+	2
8.	Tartrate	32	106	32−	1
9.	Aluminium	71	742	9+	3
10.	Ammonium	16	212	8−	6½

during which time the ammonium radical had been frequently used incidental to other work, while the hyposulfite radical had been used only occasionally, another test revealed the hyposulfite radical still the most

TABLE XI

SHOWING A COMPARISON OF ITEMS COMMON TO TWO STUDIES. RESULTS ARE STATED IN PERCENTAGES OF INCORRECT ANSWERS

Formulae	Powers test %	East High %	Rank: Powers	Rank: East High
$Al_2(SO_4)_3$	17	11	7	4
$KClO_2$	78	6	2½	6½
$NaC_2H_3O_2$	55	27	4	2
$KHC_4H_4O_4$	86	41	1	1
Ag_2S	78	9	2½	5
K_2CO_3	32	18	6	3
$FeSO_4$	45	6	5	6½
Equations				
HgO	45	23	5	2½
$Cu + HNO_3$	83	61	1	1
$N_2 + O_2$	50	13	4	5
$Na + H_2O$	65	23	3	2½
$KClO_3$	70	18	2	4
Gas-volume problems				
Temperature	55	16	2	2
Pressure	59	18	1	1
Law of multiple proportion problems				
Problems	65	36	...	...

difficult one, while the ammonium radical had moved up into the position of the easiest one.

In Table X, as to errors in valence occurring in the 45 formulae of Table

VIII, we find the tartrate radical presents the greatest difficulty, followed by the acetate radical and by the element aluminum. The valence of oxygen is the easiest to remember, among those included in the 45 formulae considered.

Lastly, in Table XI, we are comparing items in the Powers study which are included also in this study. While the absolute percentages are not comparable, as the testing conditions were not the same in the two studies, still there are some interesting comparable points as to relative difficulty of certain tasks.

Of formulae common to both investigations, the tartrates are the most difficult to write, while ferrous sulfate is an easy one.

In the list of equations common to both studies, the equation for the action between copper and nitric acid is unmistakably the most difficult: that for the action of sodium on water, also, is difficult: while the equation for the union of oxygen and hydrogen is easy.

In gas-volume problems, the pressure problems seem slightly more difficult than the temperature problems. But none of the problems common to the two studies are on the whole as difficult as problems based on the law of multiple proportion.

REVOLUTION IN MAKING GAS FUEL INDICATED BY WYOMING EXPERIMENT

Gas engineers and gas men generally are watching with considerable interest the experiment of a small gas company in Sheridan, Wyoming, which is using the local lignite deposits, which are mined adjacent to the city, for the manufacture of coal gas supplied to the residents and industries of Sheridan for heating and cooking purposes.

This is believed to be the first time that lignite has ever been used successfully in coal gas manufacture to the entire exclusion of other materials, and, if applicable to other gas companies, may result in untold economies by eliminating high freight rates and the necessity of using high priced gas or coking coal.

The use of lignite coal has already made a material difference in coal cost in Sheridan, and the city is benefited by the $2100 per month now being spent there, in addition to the reduced rate in gas which this has helped to bring about, not only owing to the lower price and greater efficiency of the coal, but the great saving on freight. Southern Colorado coal used to cost the company $376 per carload for shipment in comparison to the $15 to $18 which it now pays.

Writing in the *American Gas Association Monthly*, H. J. Forward, manager of the Sheridan Gas and Fuel Company, says:

"After conducting experiments with lignite coal for three years, I am thoroughly convinced that in the future large quantities of this so-called low grade fuel will be used for gas-making purposes. I believe that gas plant operators, particularly those within a reasonable distance from lignite coal fields, will find it well worth their while to investigate its possibilities."

Mr. Forward says that gas supplied to the city of Sheridan from lignite coal will average 535 B. t. u. per cubic foot, which is well within the legal limits set by most state commissions.

A COMPARISON OF GRADES IN GENERAL CHEMISTRY EARNED BY STUDENTS WHO (A) HAVE HAD, AND (B) HAVE NOT HAD HIGH-SCHOOL CHEMISTRY

W. A. EVERHART AND W. C. EBAUGH, DENISON UNIVERSITY, GRANVILLE, OHIO

College instructors who bitterly complain that previous instruction in chemistry may mean anything or nothing will be interested in the data here set forth. Just what advantage has the average student who has studied chemistry in high school over the average "beginner"? The author's discussion is based on records covering a five-year period.

On good authority we are assured that the question of "the poor" we will have always with us. Teachers of chemistry are almost as certain that the problem of how to care for the miscellaneous collections of students that enter college courses in chemistry will be equally long-lived, unless an educational millenium comes unannounced and ushers in a new day when the lion of a well-trained student may, with impunity, take up a position next to an inexperienced but teachable lamb to whom chemistry is a thing unknown.

Of course large universities, which must needs conduct their chemistry work in so many sections that almost any classification of students may be carried out with relative ease, can meet the problem in a different way than can the smaller college; and the professional or semi-technical school can make hard and fast requirements in the way of a curriculum (including chemistry) for its students that would not be tolerated in an essentially arts and science college with a limited number of prescribed studies and a larger field of electives open to candidates for degrees. As a result one finds among our teachers advocates of the following plans: (1) treat all entering students alike; (2) segregate those that present chemistry for entrance from those that do not, and give them separate work throughout; (3) keep the students together for recitations and lectures, but differentiate their laboratory work; (4) classify the students (by preliminary examinations or otherwise) according to their shown ability, and make requirements appropriate to each class; and (5) modify plan (4) above to the extent that the sections are not established rigidly but a flow of students may be kept up toward "A" grade at one end and "flunkers" at the other, much as in the way that a separation of silver from lead is effected in the Parkes process.

In the college from which the following data were collected, plan (3), *viz.*, keeping the students together for class-room work but using separate laboratory assignments for "Beginners" and "Advanced" students, has been followed as a kind of Hobson's choice, and it occurred to the writers that a comparison of grades earned by such students in "Chemistry 1," extending over a five-year period, might be of interest as indicating the probable fate of various kinds of students that enter the department. In this school chemistry is not a required subject, but naturally is chosen by students who expect to enter medicine, nursing, certain kinds of engi-

neering, home economics, etc. Both men and women are present in the classes, usually in the ratio of about 5:1. By far the larger proportion of the class takes chemistry simply as part of a liberal course of study, and with no expectation of applying it professionally later on. All classes from freshmen to seniors are represented. In the system of grading employed

A = approximately 90–100 and earns 2.0 "points"
B = approximately 80–89 and earns 1.5 "points"
C = approximately 70–79 and earns 1.0 "point"
D = approximately 60–69 and earns 0.0 "point"
I = incomplete (usually because of illness or other causes beyond one's control)
F = failed
W = withdrawn (for all causes whatsoever).

Chemistry 1 carries 4 credit hours towards the 128 required for graduation. (A student must make 140 "points" for graduation also.)

When he was much younger in the teaching game, at the head of the Department of Chemistry in a western State University, one of the authors was terribly depressed year after year because of the large numbers of students that fell by the wayside in college freshman chemistry. But somewhere or other he saw data compiled from records of a few of our largest and most highly esteemed schools that showed the mortality during freshman year chemistry to run from 25 to 35%, and as his own records had shown about a 30% loss he was somewhat reassured. Since then he has come to look upon it as an actuary must contemplate death—a sorrowful event for the individual concerned and those most closely connected with him, but something that is bound to occur to a certain percentage of the population annually, notwithstanding the best efforts of health officers to prevent it. The "Law of Averages" gets in its work *nolens volens*.

That the data obtained in the present study may be more easily grasped, tables have been converted into graphic form as shown in Figs. 1 and 2. In the former the number of students earning a given grade in each year (first semester only is included) is indicated by the wider bands, and the percentage of students in each of the subdivisions "Advanced" and "Beginners," is shown by narrow bands. The scale used may be found in the center of the sheet. In the latter (Fig. 2) a composite column represents the total numbers of students given the grades as indicated during the five-year period, and the percentages are represented as usual. (It ought to be said perhaps that about 15 students who registered in 1919, but whose classification is in doubt, were omitted from the above count.)

From an inspection of the graphs, comparing "Beginners" with "Advanced" students, it will be seen that

(1) A "Beginner" will have about 0.22 time as great a chance of making a high grade (A) as will the "Advanced" students;

(2) He will have about 0.75 time as good a chance to make a fair grade (B or C) as his more favored brother;

(3) He will unfortunately be 4.5 as likely to fail (all causes considered) as the "Advanced" student;

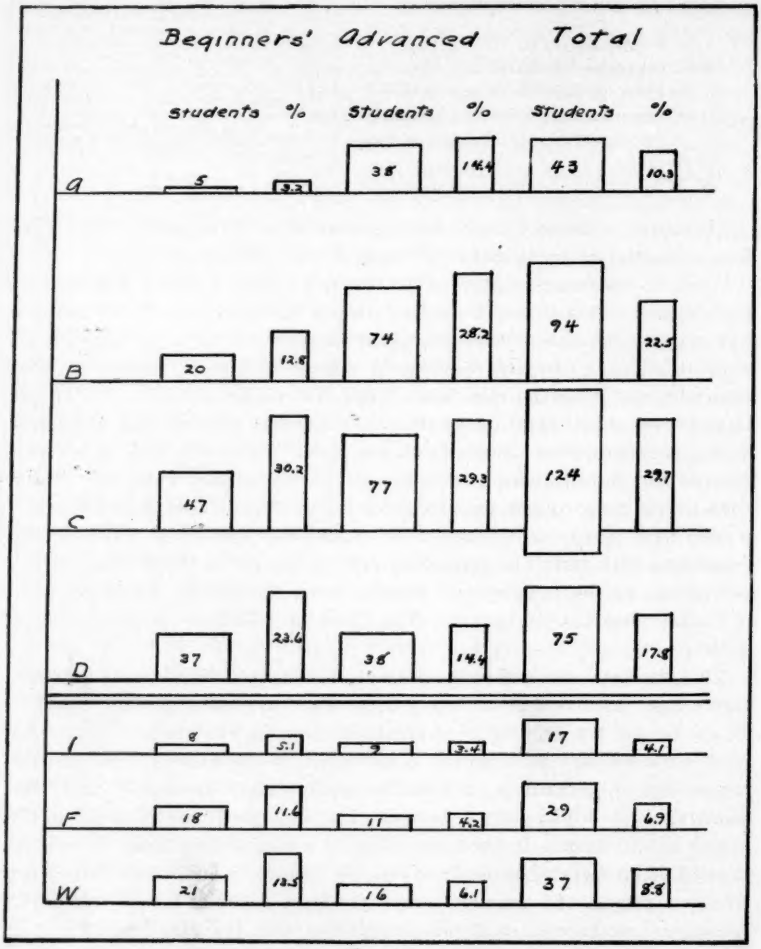


FIG. 1.

(4) Having had preparatory chemistry is by no means a guarantee of success with college chemistry, and the handicap of *not* having had preparatory chemistry will not necessarily condemn a "Beginning" student to failure.

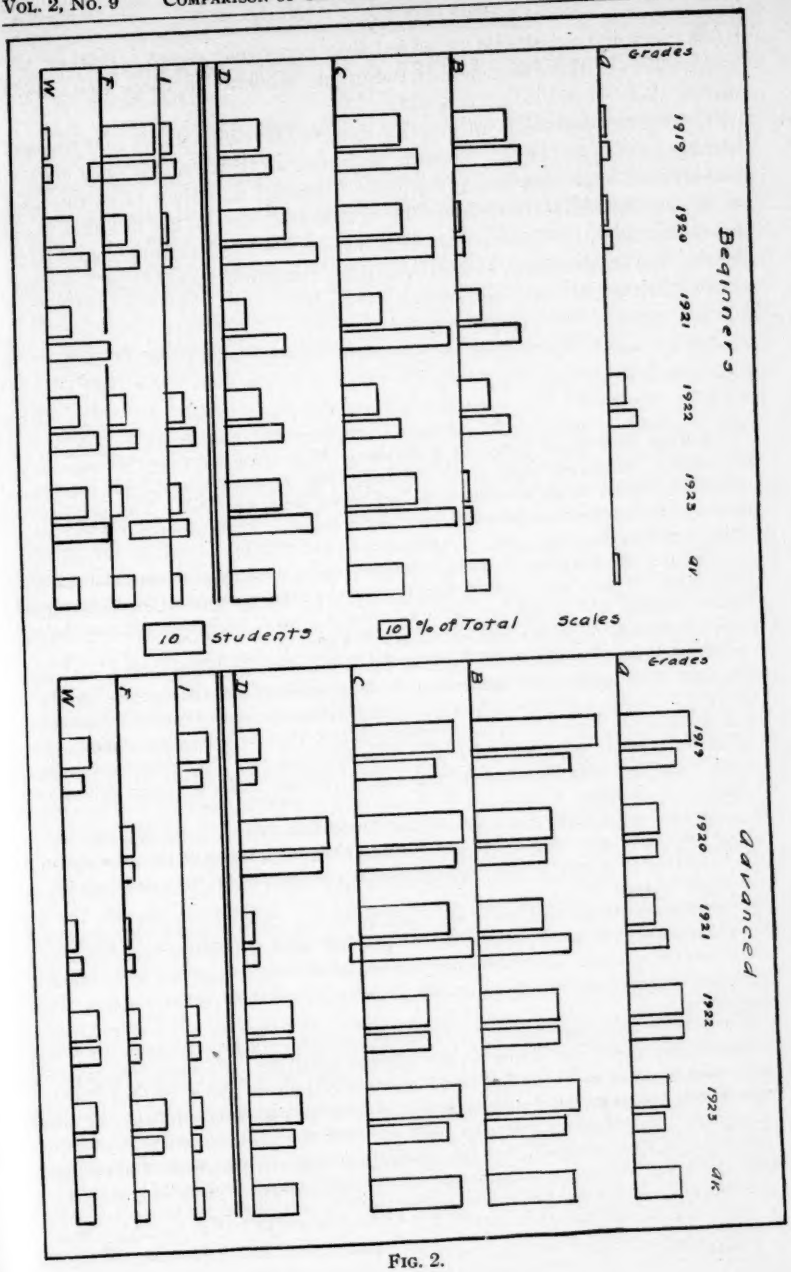

Beginners
Grades
A
B
C
D
F
W
1919
1920
1921
1922
1923
Av
10 students
10 % of Total
Scales
Advanced
Grades
A
B
C
D
F
W
1919
1920
1921
1922
1923
Av

FIG. 2.

As a corollary it should be added that experience shows a marked disappearance of the differences between the students of these two classes during their second semester's work.

The whole trend of the information depicted herewith shows that the best arrangement is to classify students according to their *demonstrated* ability, rather than their nominal preliminary training, and then have monthly or bi-monthly shifts from section to section according to the progress made by each student in comparison with his fellows, *i. e.*, maintain an educational "Parkes process," with provision for flexibility rather than a method of Procrustus, with its bed of non-variants.

X-Rays Show Inner Structure of Rubber. More than half a century ago Joule, the eminent British physicist, observed that rubber became warmer when stretched, whereas all other known substances became cooler when stretched. This peculiarity, known as the Joule effect, has ever since been a puzzle to those interested in the properties of rubber.

The clue has now been found by a Dutch scientist working in a Danish laboratory. J. R. Katz, of the University of Amsterdam, has been working in the Government Serum Institute at Copenhagen, with aid from a Danish rubber factory, on the behavior of thin sheets of raw rubber toward X-Rays.

He photographed the spectrum from a thin sheet of high-grade rubber and found the rings which appear in the spectra of all amorphous substances. He stretched the rubber slightly and repeated the experiment, with the same result. He stretched it more and made a new photograph, in which he observed an astonishing change. The "amorphous rings" were still there; but there also were the tiny bright spots which, in an X-ray spectrum, indicate the presence of crystals. The stretched rubber had begun to crystallize!

Continuing his experiments, Prof. Katz found that rubber can be stretched up to about twice its original length without crystallization; but if stretched beyond that point the formation of crystals begins, and the greater the stretch the more pronouced does the effect become.

Herein lies the explanation of the Joule effect; for all substances, changing from the amorphous to the crystalline state, give off heat. If rubber crystallizes, it must become warmer. It crystallizes if stretched sufficiently; therefore when strongly stretched it gets warmer. As usual, the fact was known long before the cause was discovered.

Prof. Katz anticipates that his X-ray studies of rubber will lead to further important results in explaining the nature of this peculiar substance. Chemists, for example, have long disputed as to the size of the molecule of rubber. Some contend that the minute colloidal particles of rubber, motion of which can be observed under the ultramicroscope, are enormous molecules built up from many smaller units, the chemical molecules. Others maintain that the colloidal particles are only loose aggregates and that the actual molecule is small, a true chemical molecule. Prof. Katz hopes, by his experiments, to throw light on this and other puzzling questions in the science of rubber.

—*Science Service*

A PLAN FOR THE A. C. S. PRIZE ESSAY CONTEST

C. ALLEN CARLSON, DELMAR (MARYLAND) HIGH SCHOOL, DELMAR, DEL.

Last year the writer attempted to formulate a plan to stimulate interest in a local prize essay contest. The plan as used was very successful when judged by the enthusiasm exhibited by the pupils, the number of pupils participating in the contest, and the appreciation gained by the pupils. Since one of the great objectives of the Chemical Prize Essay Contest is to extend an appreciation of the value of science to every-day life, the writer thought that there might be something of merit in the plan which could be adapted to the Chemical Society Prize Essay Contest. The plan explained below is the adaptation of the original one. Features which were unsatisfactory or cumbersome have been eliminated and more direct devices employed to obtain the maximum of efficiency. This is especially true of the personal conferences. The local conditions were unfavorable for trying out such a plan in the chemistry class during the past year, but this adapted plan will be used during the coming year.

It is possible to require each member of the class to present a paper on one of the subjects offered by the society. This is hardly good policy because in some cases the subjects offered are beyond the ability of a pupil to treat intelligently to the extent expected. In other cases the pupil may have aptitudes and interests in some other subject which may prove equally valuable, and in such cases the pupil may profitably expend his time in accordance with his special interest. In fact, the strength of the plan presented lies in the arousal of interest. This creates in the pupil a desire to undertake a project. It offers the further advantage that each pupil in writing the initial paper experiences much of the benefit which the prize essay contest seeks to confer.

It is well to lay the plans for the Prize Essay Contest as early as possible during the school year and preferably during the first month. This will give ample time to carry out the suggestions without undue crowding to get the papers in on time. It offers the further advantage of permitting the contestants time to gain experience with the subjects which the Society presents for consideration.

The main idea is to secure and hold the interest of the pupil. During a class period take up some interesting topic, or read some magazine article and talk informally with the members of the class during the period. Designate sources where further subject matter of this nature may be obtained. These references should be specific as to where the book may be found, its title, page, etc. A list may be placed upon the board or mimeographed copies given to each member of the class. It is best to bring all such reference books from the library and have them placed on a stand in the class-room. The pupils should be encouraged to bring books pertinent to the subject from their homes, as well as to accumulate magazines

and magazine articles which may be placed at the disposal of the members of the class. Many of these articles will be worth placing upon the bulletin board.

The next step is to make up a list of titles dealing with various phases of science. The titles should be suggestive, such as: "How is table salt prepared for market?" "Sulfur mining in the United States," or "How does Baltimore purify the city water?" Any number of such studies will suggest themselves to the instructor, but the instructor must be sure the topics are worth while. From this list of subjects the pupil may choose one and write a short paper during the first quarter of the school year. The instructor should carefully examine these papers and give each pupil proper credit. Many papers will be found which contain much good subject matter. The instructor may keep these on file and have the pupils report on them to the class from time to time as the respective subjects discussed are brought up for study. Those pupils who have presented work of real merit should be called into conference. The instructor should go over such papers with the respective authors and point out the strong and weak points of each composition. When conference work has been completed this select group should be assembled, and the plan of the American Chemical Society Prize Essay Contest explained. The pupils should be advised that some commendable material was found in their papers and encouraged to continue their work along these or other lines in competition for the prize. If a pupil's weakness in the first paper was in organizing material or in composition, the teacher of English may coöperate in rendering service. This is the best type of training in written composition.

To prevent wasted energy and consequent discouragement the teacher should aid the pupil by directing him to sources of material for the Prize Essay. The experience in looking up material for the first composition should prove helpful to the pupil now. The instructor should see that sufficient copies of the set of books* recommended by the Essay Committee are on file, that no pupil may be hampered by lack of material. The pupil must be urged to read widely upon his subject until thoroughly conversant with it. It is best not to fix upon a definite title until the pupil has read quite extensively. By proceeding in this manner the title selected may be a crystallized statement of the topic of his interest. After this he should be able to make a fairly complete outline. This should be presented to the teacher for suggestions or approval.

When the pupil begins to develop his topic the instructor should examine the papers from time to time and render aid as to sources of material, style, etc. The encouragement which the pupil receives from this personal

* The set of five books may be secured by addressing The Chemical Foundation, New York City.

contact is essential, and is a very important part of the instructor's work. These conferences are often the factor which determines whether the pupil turns out a mediocre or a good piece of work.

When the essay is completed it may be presented to the teacher of English to be scored upon its grammatical and literary merits. The paper is next presented to the chemistry instructor and credit given for it as extra class work. Should the instructor prefer, the pupil may be exempted from a monthly test in recognition of the growth attendant upon this extra preparation. If any paper is found unworthy of consideration it should be discarded from the competitive set, and the remaining papers forwarded to the committee designated in the state by the Society.

Interest plays an important part in this type of work. The teacher is the agency for inspiring this interest. Once the interest is aroused, the teacher assumes the role of the guiding, controlling, and stimulating spirit. When a desire to investigate has been instilled, the teacher may feed the interest of the pupil by live discussion in conferences and by placing literature pertinent to the subject where the pupil has access to it. Credit extended in the subject as recognition of the pupil's expenditure of extra time and effort is truly deserved; while credit extended by the English Department is a recognition of thoughtful composition on a worthwhile subject. This is the highest type of correlation.

New Syphilis Cure Found in France. What may be a sensational new cure for syphilis was unfolded before the French Academy of Sciences by Dr. Roux, the director of the Pasteur Institute, when he related the experiments conducted by M. Lavatte, one of his assistants at the Institute.

M. Lavatte has discovered a new chemical substance which he calls acetylozyamynaphenylynate; it is composed in part of arsenic and bismuth, in the respective percentages of 15 and 45.

When injected into the muscles of infected rabbits, this proved to have astonishing curative properties, small injections resulting in the symptoms of the disease disappearing within forty-eight hours, apart from sores, which took from four to five days to heal completely.

Two medical men, Drs. Fournier and Schwartz, tried this treatment on human patients. They selected thirty cases, in varying stages of the disease, which they treated with intramuscular injections of two cubic centimeters of the substance with the twenty-five letter name.

One curious feature observed was the utter absence of any discomfort, of any painful reactions during the whole course of twelve of these injections. The therapeutic effects were startling, the main symptoms disappearing within a few hours after the first injection and the sore healing with great rapidity. The Bordet-Wasserman test, on being applied at the end of the series to each subject, gave in every single case a negative reaction.

Dr. Roux added the remarkable fact that in every case, the treatment appeared to have a tonic effect on the general health of the patients.—*Science Service*

DEFINITIONS

CHARLES H. STONE, ENGLISH HIGH SCHOOL, BOSTON, MASS.

"The epistemology of Democritus was predicated upon his teleology." That is as near as I remember a certain sentence in my college text-book on philosophy. When you have got over feeling dizzy, read that sentence again and tell me what it means. Exactly so. That is just what it meant to me the first time I read it, and I am very sure that it doesn't mean anything different to me now for I have forgotten the definitions of the long words whose meanings I looked up so laboriously long ago.

If such a sentence as that given above presents difficulties to a college student, what do you say to this one for the student in the preparatory school: "Discuss, upon the basis of the hypothesis of electrolytic dissociation, the phenomena observed when (1) anhydrous copper sulfate is moistened with (*a*) benzol, and (*b*) water; and (2) when copper electrodes are inserted into the aqueous solution and a current of electricity is passed through." Isn't that lovely for the beginner? But that is easy, you say. Yes, no doubt it is—to you. You had chemistry in the preparatory school, two or three years of it in college, and have been teaching it more or less since then. But imagine some hopeful Jane or Johnny coming across a sentence like that, or other sentences containing such words, and consider how much mental nourishment they will be able to extract from that sort of pabulum.

When a paleontologist digs and finds a bone he knows what it means. He knows that there are other bones near by. He digs some more and then assembles and sets up his discovery so that the visitor to the museum may gaze in wonder upon Brontosaurus or Triceratops in all their mighty majesty and the sight may mean something to him. To a degree its meaning has been interpreted, has been defined, for him. But the young scientist who discovers a formidable new word in his chemistry lesson is not likely to dig very deep in the dictionary for its meaning, nor is he likely to consider that some more fossil thoughts in the shape of other new and difficult words may be lying about in the pages following the present assignment. Unless that new word and every new word is adequately defined for him in language which he can understand, that word has no meaning, or he gives it a wrong meaning, and so the whole paragraph in that lesson assignment fails to make the right impression upon the mind.

We cannot expect the student to derive meanings for himself as might once have been done in the days when Greek and Latin formed a fundamental part of all school training. Students will not often look up definitions of new words; neither will many older people. How many times do you run across an unfamiliar word in your reading? How many times do you turn to the dictionary to find the interpretation of that word? Not often, unless you are a cross-word puzzle fan. The inertia of the mind

is surprising. Newton states it very well in his Laws of Motion: "Minds at rest tend to remain at rest, and minds in motion tend to continue in motion in a straight line." No turning aside, you will observe, to look up definitions. Perhaps Newton did not use my precise language but he evidently had the right idea.

Definitions! Certainly. We must have them. Without them much of the student's study is meaningless. Bulwer says, "In the bright lexicon of Youth there's no such word as fail." Maybe Bulwer is right, but I am sure that in the bright lexicon of Youth there are also no such words as: electrolyte, amorphous, efflorescence, cation, anhydrous, catalysis, and—well, you know what they are. Unless these words and many more like them are clearly defined for Jane and Johnny, chemistry will, likely enough, fail to arouse in them much enthusiasm and the word "fail" will get into Youth's bright lexicon after all in spite of Bulwer.

Definitions! Certainly. As teachers of chemistry we must see that we accomplish two things in regard to words: we must see that they are accurately and clearly defined. Not always to our satisfaction do our texts define difficult words. Once well defined, then we must see that each new word is used in the correct sense in the class-room, not only by the teacher but by the pupil who must see it, hear it, speak it, write it, absorb it, know it. Not otherwise will he be able to understand the sentence and paragraph in which that word occurs; not otherwise will he be able to get the full significance of the topic he is studying. A knowledge of the meaning of words is fundamental to any clear understanding of the assigned lesson. Without that knowledge of words, arrived at by clear and adequate definitions, there is loss of comprehension and subsequent loss of power. It is like the old story of the kingdom which was lost for want of a horse-shoe nail. For want of a definition a word is lost, for want of a word a sentence is lost, for want of a sentence an idea is lost, and for want of an idea the student is lost.

When Polonius asked Hamlet: "What do you read, my lord?" the melancholy Dane replied: "Words, words, words." It is up to us as teachers of chemistry to see to it that definitions are made sufficiently simple and clear so that the student will comprehend the ideas conveyed by the new and difficult words as they appear from time to time and will not regard them as meaningless sounds, mere "Words, words, words."

France to Salvage Fish Refuse. A project for making a new food product from the large quantities of fish refuse left daily at Boulogne-sur-Mer by great fishing fleets has been patented in France and rights have been obtained for the United States, according to a consular report. Heretofore this refuse was carted away by representatives of fertilizer manufacturers who obtained it without payment, but now a large canning and packing concern is interested in making an extract out of it resembling that of beef.—*Science Service*

THE USE OF PROBLEMS IN TEACHING COLLOID CHEMISTRY

F. O. ANDEREGG, PURDUE UNIVERSITY, LAFAYETTE, INDIANA

In administering an elementary course in physical chemistry, the selection of material for presentation constitutes a very nice problem. Of all the various branches of physical chemistry, none has a greater interest for the student and none gives him more valuable training than colloid chemistry. The great range of phenomena covered by the principles of colloid chemistry and their close connection with most operations of everyday life make their study one of especial appeal to most students.

Since most of the laws of colloids that are suitable for teaching in an elementary course are qualitative in character, numerical problems cannot be depended upon to drive them home. To satisfy this deficiency, a list of problems has been collected which can be given, a few at a time, for the student to analyze and hand in. A reasonably complete analysis of the various factors which contribute to a given result is at first quite difficult to the average student and he is apt to become discouraged. However, the practical nature of the problems, themselves, together with *very full* discussions of the problems in class and encouragement from the instructor, result in the student gradually acquiring a much greater ability to handle new problems. These exercises also work very well in graduate courses in colloid chemistry.

The first one in the list has been treated by Bancroft.[1] In addition to the question of simple displacement of the air film on the canvas fibers, the question of the action of any sizing or waterproofing on the wetting must be considered. Hydrophobic substances aid in the shedding of water because of the difficulty of replacing their air film by one of water. The explanation of waterwings involves the opposite effect; the fabric is thoroughly wet with water and the surface tension of the water between the fibers tends to prevent the air from escaping. Problem 31 refers to the common occurrence of iron in most stones which on heating often become red owing to the growth in size of iron oxide particles at the elevated temperature and a resultant change in structural color. The principles covered in the other problems should be evident to any persons familiar with the more common laws of colloid chemistry.

1. A tent roof is touched during a rain.
2. A drop from a paddle may roll on the surface of the water for an instant.
3. A jet of water breaks up.
4. Waterwings.
5. Making a good mercury barometer.
6. Under-sea painting.
7. "Everhot," sold by drug stores consists apparently of roasted iron filings. A *little* water is added to produce the heat.

[1] Bancroft, "Applied Colloid Chemistry," McGraw-Hill, 1921, p. 71.

8. "Magnesia" pipe coverings may contain more than 90% of voids.
9. A turbulent flow encounters more resistance than slip or telescopic flow.
10. Turbulent flow gives better heat transfer.
11. A good soldering (or brazing or welding) flux.
12. Make a list of examples where union occurs between pieces of metal without solder, cement, etc.
13. Asphalt sticks to the edge of the cutting knife.
14. Rubber erasing, wet and dry.
15. Drilling a hole in glass.
16. Grinding with a wet sandstone.
17. A drop of water falling on silk may leave a ring.
18. A good shoe-polish.
19. Prepared paste, *Argerol*, etc., should be added to water—not vice versa.
20. Bone fertilizer is hard to wet.
21. "Only 95% of mercury vapor is usually condensed."
22. Good chalk crayons are made from plaster of Paris.
23. Adding 50% bentonite to soap often improves its detergent power.
24. Jewellers use fine sawdust in cleaning.
25. Wall paper cleaning.
26. Red mercuric oxide on grinding turns yellow.
27. The color of very fresh iron rust.
28. The metallographist's heat tinting.
29. Colors of carborundum.
30. "They smoked till the air was blue."
31. Most stones acquire what color on heating?
32. What colors may be produced by adding varying amounts of lamp black to white lead ground in linseed oil?
33. Freezing of fresh concrete.
34. Freezing of a tender plant.
35. Freezing of a hardy plant.
36. Very rapid freezing of ice cream.
37. Very rapid thawing of ice cream.
38. Very rapid thawing of a hardy plant.
39. The effect of a slag, containing much iron, as a fertilizer.
40. The removal of coal tar from the skin.
41. A paper (cigarette) sticks tenaciously to the lip.
42. The removal of ordinary ink stains from cloth.
43. The de-inking of newspapers.
44. Making cow's milk digestible for infants
45. Ammonia is added to rubber latex before shipping.
46. The effect of time and temperature of heating ferric oxide on its solubility in hydrochloric acid.
47. A good putty.
48. Dehydrating sewage sludge.

SAFETY FIRST IN STORING CHEMICALS[1]

H. F. DAVISON, BROWN UNIVERSITY, PROVIDENCE, R. I.

"Chemicals should be treated with a great deal of respect." This statement which we hear so often and which is so obviously true, will bear repeating many more times, for the careless handling of chemical substances can produce serious consequences. When a disastrous fire occurs in a school building it is very frequently traced to the chemical laboratory and the general verdict is "spontaneous combustion."

It occurred to the writer that it might be interesting to investigate which of the substances generally found on stock-room shelves were likely to cause fires by their improper storage. Several combinations, not generally mentioned, that could easily have caused a wooden building to be burned, were met with, and they are here set down for the benefit of those who may not have happened to think of them in this connection.

Such dangerous combinations as are well known, like sodium or potassium and water, considerable quantities of quick lime and water, concentrated nitric acid and turpentine (or wood), rags or waste covered with linseed oil, phosphorus and air, need not be spoken of at length. Suffice it to say that great care should be exercised in their storage and use.

Phosphorus should be kept in a glass container which is placed in another container of metal, as the metal is less likely to be broken than the glass. Before leaving for any extended time (as for the summer vacation), the phosphorus in the double container should be set into as tone crock, covered completely with water and placed in the sink. The crock should be covered to prevent evaporation. One will rest easier should a fire occur, if he knows he has taken these precautions.

To demonstrate to yourself or to your students how a chance breaking of two bottles containing apparently innocuous substances, in combination with a leaky roof, might set fire to the laboratory, try the following experiment:

On a sheet of asbestos spread a layer of *dried* ammonium nitrate (granular) making a flat disk of it about five cm. in diameter and five mm. thick. On this spread a smooth layer of zinc dust (also dried). Make a cavity in the center of the layer so that the white crystals of the ammonium nitrate show through the layer of zinc. Now with a long rod or tube put *one* drop of water in the depression you made and await results.

In a similar manner you can start a fire with equal parts by volume of powdered iodine and fine aluminium powder. These must be mixed dry by shaking in a bottle and will ignite with beautiful effect when slightly moistened.

A mixture of equal parts by volume of sodium peroxide powder and fine

[1] Paper read before the New England Association of Chemistry Teachers at Brown Univ., Mar. 14, 1925.

shavings or fine planer chips will also ignite with great violence on addition of a drop of water. This shows the danger of dispensing sodium peroxide on filter paper, and the danger of stowing it away in wooden lockers where it may get wet. A pile made similarly will be set on fire by the stream of sulfur dioxide from a tank of this gas.

It is a crime, I am told, punishable by fine of $30.00, in a certain laboratory to put a piece of charcoal into a locker. This is a wise and necessary precaution on the part of those in charge for nothing holds the heat like charcoal and it is nearly impossible to tell when the fire is all extinguished on it.

Carbon disulfide is so easily inflamed that on one occasion we had a can of it take fire as it was being siphoned through a rubber tube. No flames were near and the only explanation we have is that it became electrified and a spark jumped into the vapor.

Such a substance as zinc ethyl which is spontaneously inflammable should by all means be kept where, if it lights, it can do no harm and only small lots of it should ever be on hand.

There is probably no new chemistry here for any who will read it, but possibly the thought of safety in storage will be quickened by those who try out some of the demonstrations here recorded.

X-Rays Will Speed Laboratory Analyses. Rapid analyses of materials in the laboratory by the use of X-rays in a much shorter time than required by the older chemical methods, is promised by Prof. Urbain, of the Minero-Chemical Laboratory at the Sorbonne. With the assistance of Eugene Delaunay, he has just completed a series of tests of the X-ray method.

The apparatus used is composed of an X-ray tube; a lead screen in which a small slot has been pierced; a "selector" of tantalum, as a filter for the rays; a stand to hold the piece to be studied; and a detector to measure the intensity of the radiation received —the intensity being indicated by the displacement of an illuminated spot.

The material to be analyzed is placed in the beam, and when it is in good condition, the spot of light remains stationary; but if a fault in the material appears, the electrometer registers promptly. By recognized laws of physics, the deviation is proportionate to the amount of the fault in the matter. By this method, the smallest faults can be detected.

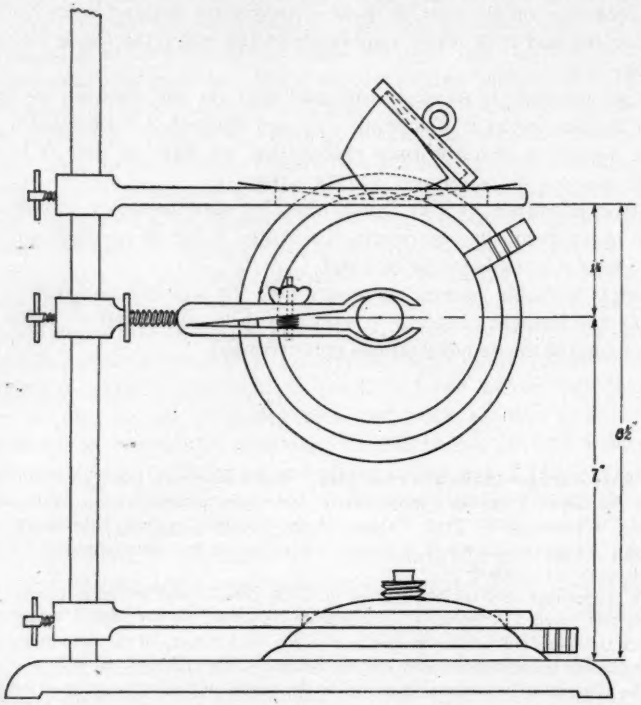
For actual quantitative work, the movable holder for the material is replaced by a small basin. By using, for example, distilled water as a base, and placing this first in the basin to set the "zero starting point," other solutions containing salts can be analyzed by straight calculations. For more than one salt in solution, more than one wave length can be used.

The great advantages of this would be first for the speed of analysis, and second that a constant watch and check can be kept on the material used in manufacturing. M. Delaunay, who did the actual work, also says that there is no risk of error, which greater accuracy should prove invaluable.—*Science Service*

AN AUTOMATIC BLAST LAMP

E. F. ACKELSON AND C. C. KIPLINGER, MOUNT UNION COLLEGE, ALLIANCE, OHIO

The junior author of this note discovered that the ignition of precipitates was expedited to a marked degree by removing the tube of the Bunsen burner used for the ignition, and allowing the stream of gas and air to play against the red-hot crucible, which ignited the explosive mixture and produced a very intense heat. The dangerous possibility of an accidental shift of the gas jet, or a cooling of the crucible to a point below the ignition temperature of the gas mixture, led to the adoption of the set-up shown in the figure, which includes a second Bunsen burner to serve as a pilot lamp.



This has proved to be the most efficient laboratory burner the senior writer has ever used, surpassing the Meker at its best. A little experimenting will show the best distance relations of the several parts for maximum heat effects. The distances given in the figure proved best for the gas pressure available in our laboratory.

AN ANALYSIS OF HIGH-SCHOOL TEXTS IN CHEMISTRY*

ARTHUR H. BOTHE, UNIVERSITY OF MISSOURI, COLUMBIA, MO.

Since the text-book forms the basis of subject-matter in chemistry courses of our secondary schools, four of the leading texts were analyzed to ascertain the percentage distribution of subject-matter. The outline of the standard minimum high-school course in chemistry proposed by the American Chemical Society has been included in the study. One of our objects was to compare the relative emphasis laid on the important phases of high-school chemistry with the criteria for the selection of subject-matter in a secondary school course of study in science. Is the organization of the high-school chemistry texts in harmony with the criteria for the presentation of the subject-matter of the course of study in secondary school science? Finally we venture to suggest some changes in the content of the texts to bring them more into harmony with the criteria we have laid down for the construction of high-school texts in chemistry.

In compiling the percentage of space given to different phases of subject-matter, variations in size of type were corrected for by reducing all space to a single standard. The four texts analyzed are designated A, B, C, D, in the tabulated data. The texts are:

Text	Authors	Title of Text
A	McPherson and Henderson	Chemistry and Its Uses
B	Brownlee and Others	Elementary Principles of Chemistry
C	Black and Conant	Practical Chemistry
D	Dull	Essentials of Modern Chemistry

TABLE I

PERCENTAGE OF SPACE OF TEXTS DEVOTED TO VARIOUS PHASES OF THEIR SUBJECT-MATTER

Phases of subject-matter	Symbols for texts A	B	C	D	Average
1. Theoretical considerations	13.3	16.3	14.8	12.3	13.9
2. Descriptive material					
(*a*) Descriptions of elements, compounds, etc.	30.2	34.3	32	25.1	30.4
(*b*) Illustrations	8.2	10.2	9.3	11.3	9.7
(*c*) Explanatory material	7.3	6.5	8.1	8.2	7.5
(*d*) Historical consideration	3.7	3.8	1.2	3.2	3.0
Total descriptive material	49.3	54.9	50.6	47.8	50.6
3. Organic part	13.9	7.7	10.2	10.4	10.5
4. Equations and calculations	4.7	5.5	4.8	3.2	4.5
5. Valence	0.9	1.2	1.6	1.6	1.3
6. Everyday applications	11.9	12.0	9.7	13.0	11.6
7. Industrial and commercial considerations	11.4	14.8	13.1	17.1	14.1
6 and 7. Everyday applications and industrial considerations	23.3	26.8	23.0	20.2	25.8

* Abstract of a thesis submitted in partial fulfilment of the requirements for the degree of Master of Arts in the Graduate School, University of Missouri.

TABLE I. (*Concluded*)

Phases of subject-matter					Average
8. Exercises for pupils	10.2	8.9	6.3	5.5	7.7
(*a*) Everyday applications	1.6	1.4	1.1	1.5	1.4
9. Subject-Matter (average of four texts) devoted to consideration of health					0.84
10. Subject-Matter (average of four texts) devoted to usefulness of applications in the home					5.24
11. Subject-Matter (average of four texts) devoted to vocational guidance					0.25

An investigation of similar scope but in less detail has been conducted by Cornog and Colbert.[1] In the main our percentages run closely parallel to theirs as shown in Table II.

TABLE II

	Theory	Descriptive material	Useful applications	Equations and calculations
A	13.94	50.6	25.7	4.55
B	13.1	56.8	25.2	4.9

A—Our analysis shows that 13.94 per cent of texts is theoretical, and

B—Results of Cornog and Colbert show that 13.1 per cent of texts is theoretical.

The criteria for the selection of subject-matter used in the evaluation of the content of the texts analyzed are briefly stated as follows:

1. The subject-matter offered in the secondary school should be determined by the function of the school.

   (*a*) The function of the secondary school is to meet those needs of the pupil which are not effectively and economically supplied by other institutions.

2. The nature of the subject-matter offered in the secondary school should reflect the influence of the purposes of the secondary school.

   (*a*) The list of ideals which has received the widest distribution and is accepted as authoritative is the one proposed by the Commission on the Reorganization of Secondary Education, namely, health; command of fundamental process; vocation; worthy home-membership; citizenship; worthy use of leisure, and ethical character.[2]

3. The objectives of secondary education should be accompanied by activities in which they are realized. "Self-activity is a law of growth."[3]

4. The pupil's interest must be given consideration in the selection of subject-matter. Interest secures attention and makes self-activity possible.

[1] *Sch. Sci. Math.*, **24**, 168–73 (1924).

[2] "Cardinal Principles of Secondary Education," U. S. Bur. Educ., *Bull.*, No. **35**, pp. 11–5 (1918).

[3] "Reorganization of Science in Secondary Schools," U. S. Bur. Educ., *Bull.*, No. **26**, p. 12 (1920).

5. All subject-matter included in secondary school text-books should appeal as beneficial to the pupil. Interest to be sustained must rest on the perception of worthwhileness to the individual for the purpose which he seeks. Subject-matter becomes "worthwhile" for the pupil when he sees that it functions in the daily life of the individuals about him.

Let us apply these criteria for the selection of subject-matter to our findings of the analysis.

The analysis does not reveal that the texts offer or stress any specific subject which the secondary school pupil usually masters outside of school. The results of the analysis, however, show that much subject-matter in the field of high-school chemistry, not mastered by the pupil in the normal process of living, is not duly emphasized, and in some cases is not mentioned in the high-school chemistry texts.

A study of the results of the analysis indicates that less than one per cent of the content of the high-school chemistry text is devoted to subject-matter on health. If this important object which affects the social, economic, cultural and aesthetic phases of the pupil's life, is to be realized in a course in high-school chemistry, more space in the text must be allotted to it.

Only about five per cent of the content of the chemistry texts used in high schools today is devoted to matters pertaining to the home and to home life. Therefore, it is evident that our texts are also weak in their emphasis upon this objective.

The subject of chemistry should contribute both to vocational guidance and to a broad preparation for a vocation. These purposes will not be realized until more of the subject-matter of our texts is adapted to the needs of the pupil. The total amount of space allotted to "Everyday Applications of Chemistry," including "Industrial or Commercial Considerations," and subject-matter relative to the work or to the field of the chemist is only about twenty-six per cent of the average text. In the high school, chemistry cannot be expected to function in the realization of the objective, vocation, until our texts lay more stress upon such topics as these.

According to the data, about three per cent of space is given to the historical phase of the subject. In view of the untold services rendered by chemistry to civilization, should not this per cent be materially increased?

Again, the analysis shows that our texts use only about seven and one-half per cent of the space for problems, but of this space only one and four-tenths per cent is devoted to problems of everyday life. If we include the laboratory manual in our study we find that only eight per cent of the space of the subject-matter devoted to exercises, which amounts to about thirty-two per cent of the entire subject-matter, functions in the everyday, practical life of the pupil. If the subject of chemistry is to function in the

realization of the objectives of secondary education, provision, not only for activities, but for activities which touch the everyday life of the average individual, must be made.

Almost half of the content of the average text is devoted to descriptive subject-matter, the greater part of which does not function in the daily life of the average individual. Is some of the subject-matter of our texts really worthwhile? It is true that most of the subject-matter of the high-school texts is useful in one way or another. The results of the analysis, however, show that not more than twenty-five per cent is devoted to subject-matter which is used directly in the daily life of the average individual.

Perhaps the space devoted to theoretical considerations finds justification in the fact that so much emphasis is necessary for a clear understanding and appreciation of the many chemical reactions which the pupil meets in his everyday life. It is difficult, however, to justify on the basis of worthwhileness the over-emphasis given to descriptive considerations in our high-school texts. That some direct benefit may be gained by the average high-school pupil from the descriptive considerations is admitted, but that very little of this subject-matter really functions in the daily life of the average pupil is also apparent. Probably little would be lost, and perhaps something gained, if much of the subject-matter on the preparation and properties of many of the elements were omitted. Other subject-matter which actually functions in the daily life of the average individual and which is not found in our high-school chemistry texts might be inserted in place of that which was omitted, although to use and to teach thoroughly the remainder of the subject-matter without any substitution might be well. If the criterion, worthwhileness of subject-matter to the pupil, is applied in the selection of descriptive considerations, only a small portion of those now included will find a place in the high-school chemistry text.

The Content of the Texts Versus the Recommendation of the Committee on Chemical Education

The results of the analysis of the content of the texts should also be evaluated on the basis of the recommendations of men in the field of chemistry. This may be accomplished by comparing the results of the analysis of the texts with similar results obtained from an analysis of the outline of "A Standard, Minimum, High-School Course in Chemistry,"[4] as recommended by the Committee on Chemical Education of the American Chemical Society. This outline is a true recommendation of the trained chemist, as it embodies the opinions and the criticisms of more than thirty thousand individuals interested in chemistry.

A general analysis of the outline of "A Standard, Minimum, High-School

[4] "Correlation of High-School and College Chemistry," THIS JOURNAL, 1, 87–93 (1924).

Course in Chemistry" as worked out by the Committee was made. The method of procedure used for the analysis of the texts was also applied to this outline. In considering this analysis, attention should be given to the condensed form in which this subject-matter appears and to the difficulty encountered in an attempt to make an analysis of such condensed subject-matter. The results of this analysis are being used with this in mind. The data obtained from the analysis in comparison with the results of the analysis of the texts are given in Table III.

TABLE III

PERCENTAGE OF CONTENT OF TEXTS DEVOTED TO IMPORTANT PHASES OF HIGH-SCHOOL CHEMISTRY, AND PERCENTAGE OF SPACE RECOMMENDED FOR THESE PHASES BY THE COMMITTEE ON CHEMICAL EDUCATION

Texts	Theory	Descriptive	Everyday applications	Industrial	Definitions	Organic chemistry
A	12.3	30.2	11.9	11.4	7.3	13.9
B	16.3	34.3	11.9	14.8	6.5	7.8
C	14.8	32.0	9.7	13.1	8.1	10.2
D	12.3	25.0	13.0	17.1	8.2	10.4
Av.	13.9	30.4	11.7	14.1	7.5	10.5
X	10.8	49.6	22.9	14.3	4.2	2.0

A—Analysis of text A shows 12.3 per cent of text devoted to theory.

Av.—Average of texts A, B, C, and D, show 13.9 per cent of text devoted to theory.

X—Analysis of outline of "Standard, Minimum Course in High-School Chemistry" shows 10.8 per cent of text devoted to theory.

Table III indicates that the results of the analysis of the texts compare well with those of the analysis of the outline for "A Standard, Minimum, High-School Course in Chemistry." Only a few deviations are observed. All the texts analyzed show a higher percentage in "theory" than is recommended by the Committee. This deviation, however, is only slight. If the figures resulting from the analysis of the Committee's outline truly represent the Committee's recommendation for a high-school course in chemistry, they offer a refutation to those who advocate a greater stress on theory in high-school chemistry. A greater deviation is observed in the case of descriptive-material. This may be due in part to the fact that it was impossible to make a detailed analysis of the condensed form of the outline, as was done in the analysis of the texts. However, the deviation is better accounted for by the fact that the Committee's outline has been prepared with a view of meeting the college entrance examination requirements.

The outstanding deviation is found in the case of "Everyday Applications." The Committee recommends practically twice the amount of subject-matter given this phase. The stress placed upon this phase of the subject by the Committee is none too great. The organic side of chemistry

is not much emphasized by the Committee, probably because of the difficulty which is encountered by the high-school pupil in attempting to master an extensive treatment of this branch of chemistry.

The preceding consideration of the content of high-school chemistry texts on the basis of recommendations of individuals in the field of chemistry, points out the fact that the practical or useful side of high-school chemistry is not sufficiently stressed in our high-school text. This fact was also revealed in the evaluation on the basis of the criteria for the selection of subject-matter for a secondary school course of study in science, and should receive the attention of the high-school chemistry teacher. A course in high-school chemistry is not in harmony with the purposes of the secondary school unless it emphasizes the practical or useful side of chemistry more than it is at present emphasized by our high-school chemistry texts.

Our conclusion drawn from this first part of our study is very evident. The average high-school chemistry text-book now in use is not adapted to the capacities, interests, and needs of the secondary school pupil.

As a result of our attempted analysis of the texts relative to their organization the following facts become evident.

1. All texts analyzed may be classified as logical (organized according to the mind of the expert and not according to the abilities, interests, and needs of the secondary school pupil).

2. No definite plan for the introduction of theories, principles, laws, etc., according to their need or use seems to be followed.

3. The nature of the content of the first chapter of the texts is usually "definition type."

4. Theories and their examples are presented inductively: *i. e.*, example first and theory following.

5. Important phases of subject-matter are not repeated often enough in the texts.

In the evaluation of these facts the following criteria were used:

1. The subject-matter should be in part organized according to the criteria of interest and utility.

2. In grading subject-matter the ability of the pupil should be recognized as a very vital factor.

The conclusion drawn from the results of this part of the analysis is that our present high-school chemistry texts are not organized with the greatest possible attention to the criteria of interest, utility, and difficulty. These principles should be given more consideration in the organization of the subject-matter of our high-school chemistry texts. If these principles were strictly applied, our course in high-school chemistry would not so often be labeled by the pupil as "difficult" and he would derive greater practical benefit from the subject.

In conclusion, lest we forget, let us repeat that the average, present, high-school chemistry text-book does not coincide with the standards which should govern the selection and organization of the subject-matter for a secondary school curriculum.

Our study leads us to two general conclusions which are not exactly new. We are convinced that school administrators and high-school teachers of chemistry should give greater attention to the matter of selecting a chemistry text. The teacher of high-school chemistry should also realize that he cannot rely entirely upon the content and method of presentation of the average chemistry text-book for the subject-matter of his course; but that, in addition to the subject in the text, much other material of interest and use to the high-school pupil should be offered. This additional subject-matter should be presented according to its degree of difficulty, according to its interest to the pupil, and at the point of his greatest need.

This investigation was conducted under the direction of Professor A. G. Capps, School of Education, University of Missouri. Valuable suggestions were also received from Professor Herman Schlundt, Department of Chemistry, University of Missouri. Mr. James E. Wildish of the Kansas City Junior College has helped in preparing this abstract.

Fireproof Gas Tanks Like Puncture-Proof Tires. An aeroplane gasoline tank which may be completely riddled by incendiary or explosive bullets without bursting into flames, or even leaking, is the latest development in the aviation field which comes from Vienna. The tank is the usual metal type, but with a peculiar interior coating, the composition of which is a carefully guarded secret with the inventor, probably on the order of the liquid gums placed in automobile tires to make them puncture-proof. There is also, according to the claims of the patentee, a special mechanism inside the tank which eliminates all the effects of explosion, either of bullets or of gas fumes.

The inflammatory bullet, upon entering the tank, is immediately enveloped with a coating of some sort of material that extinguishes the flame, and at the same time prevents a phosphorous coated bullet from leaving a deposit.

In a test made by expert army witnesses, a series of twenty bullets was fired through the experimental tank, which was filled half with gasoline and half with inflammable gas. The bullets were fired in a series of one explosive, one phosphorous, and one solid, in rotation. After the twenty rounds had been fired with no bad results, the tank was set in an aeroplane, which then made an hour's flight using only the gasoline from the apparently perforated tank. No leak or fire occurred, and no other trouble of any kind.

The invention is arousing great interest in the war department, as the figures of the past Great War taken from the German war office show that 80 per cent of the planes brought down in flames were fired either from phosphorous bullets, or caught fire from tank leaks.—*Science Service*

CHEMICAL POSTERS

ADELINE H. JACOBS, GERMANTOWN HIGH SCHOOL, PHILADELPHIA, PA.

Permanent decorations in a class-room are often taken for granted by students, after their novelty has worn off. The framed masterpieces,* whose influence is not to be belittled, are not viewed with the same lively interest which amateur decorations of a more transient nature may arouse.

It is suggested, therefore, that the teacher gradually accumulates a collection of posters illustrating chemical subjects. While these pictures are not to be compared with the reproductions of fine paintings, yet they have a distinct place on the walls of the laboratory or class-room.

They catch the attention of the student for several reasons. Primarily they illustrate a topic under discussion in the current work in chemistry. If the poster is a good one, "he who runs, may read." Besides, the students study the posters because they themselves may be preparing some for a drawing lesson, or for a health campaign, or what not. The personal element may enter in, if they know the student whose poster in chemistry is on exhibition.

As the teacher refers to a poster hanging on the wall, she may suggest that it would be valuable to have some new ones on a specified topic, or to replace old ones that have lost their freshness with use. In this way, the collection is continually growing and improving. It will come in very handy, when a parent-teachers meeting is held at school. These posters make quite an attractive array and never fail to arouse favorable comment.

The subjects in chemistry which lend themselves to poster treatment are legion. When the teacher begins to think "Posters," she will find that the field is limited only by her time and enthusiasm, and by that of her pupils.

Fire-prevention is a subject which is required to be taught in the schools of Philadelphia each autumn. After having read booklets and circulars issued by the National Board of Fire Underwriters, my classes prepared a set of posters. As these were decidedly clever and striking, let me describe a few.

A picnic scene showed boys and girls sitting on the grass, enjoying a meal cooked over a wood fire. The legend read:

"Extinguish Your Camp Fire"
"Prevent Forest Fires"

Another poster asked, "Where Does He Throw It?" A cigarette and a used match were sewed on to the sheet of cardboard. A hole with charred edges had been burned in the paper. A man's head in silhouette completed the story.

* See "Chemistry as Depicted in Art," THIS JOURNAL, **2**, 111–3 (1925).

A poster which combined the efforts of several students was called "Clothed by Chemistry." A figure of a lady of fashion, about ten inches in height, had been cut from the cover of a magazine and mounted on cardboard. Lines radiated from her hat, necklace, rings, blouse, buttons, skirt, stockings, shoes, etc., suggesting the anatomical figure in the patent-medicine almanac, with the lines leading to the signs of the zodiac. The lines, coming from our lady, reached the margin of the mount where the indicated articles were duplicated—hat, necklace, etc. Accompanying each article was a paragraph written by a student, detailing how chemistry contributed to the final product. Such topics as chlorine bleaching of cotton fabrics, rayon silk, mercerized cotton, the weighting of silk for stockings with tin, metallurgy of gold, etc., appeared. The lady "clothed by chemistry" was not companionless, as there were also a man and a child "chemically costumed."

Perhaps this seems childish play. Remember that children of fifteen and sixteen years were engaged in hunting through text-books and magazines to find suitable material for the paragraphs on their special topics. The idea that the short paper was not just to be read aloud in class, but was to be part of a poster, and to be exhibited with one's name signed to it, added special interest to this bit of reference work.

One student who wished to illustrate "The Removal of Stains" found an advertisement of a soap, in which a nurse-maid was surrounded by a family of children, little and big, awaiting their turns to wash face and hands. The student added an assortment of spots of different colors and kinds to stockings, trousers and blouses. At the outer ends of the lines leading from each stained article of clothing was printed the name of the kind of spot—grass, paint, tar or ink, an actual sample of the spot, and directions for removing it most successfully by chemical means.

A call for posters showing the application of chemistry to daily life resulted in a pleasing variety. A few of the titles or legends of these artistic attempts to interpret scientific facts are listed here.

a. CO_2 Raises Bread.

b. Crisco from Cotton-seed Oil
Hydrogen Does It.

c. Thank Sir Humphrey Davy
for
Nitrous Oxide Gas.

d. Hydrogen Sulfide Discolors Silver.
(Silver spoon, egg-cup, empty egg-shell—pictured)
Equation given.

e. Soap Making.
Kettle of Fat + Can of Lye $\longrightarrow$ Soap + Glycerol.
(pictured) (pictured) (pictured) (drug label)

f. Perfumes sweet,
Colors gay
Come from coal-tar
Every day.

The reading up of the subject, keeping it in mind until a means of expressing it graphically is found, and condensing many words into a forceful title, all these surely have their educational value.

The posters with their bold printing and colorful drawings certainly add to the attractiveness of the class-room. I hope that teachers will feel that the suggestions offered here are worth trying and that it will brighten up things to "Say it with posters."

Flame Burned under Water Saves Fuel. Burning an oil flame under water for weeks at a time, and avoiding most of the heat loss of an ordinary boiler, is the feat of Oscar Brunler, a Belgian scientist.

By means of a device similar to a carburetor, a spray of crude oil mixed with air is blown into the burner under pressure. Water is kept out of the burner until it is hot and the fire is burning well. Then the water is allowed to rise around the flame until it is submerged. Once started it can be kept burning for months.

All designs of boilers are based on the principle of bringing the flame of the fuel into the closest possible contact with the water in order to avoid loss of heat. The most efficient method is to have the flame directly in the water, and this is what Brunler has succeeded in doing.

His success is shown by his report to the Society of Chemical Industry. More than sixty different kinds of oil have been burned, and boilers have worked continuously for months. The flame can be regulated completely by turning one wheel. While an ordinary burner seldom gives as much as 75 per cent of the heat, as determined by common methods of analysis, this submerged flame has given a heat efficiency of practically 100 per cent for weeks at a time.—*Science Service*

PREPARING CHEMICAL EXPOSITION DIRECTORY

An industrial directory of exhibitors in the Tenth Exposition of Chemical Industries which will be held in New York at the Grand Central Palace during the week of Sept. 28th to Oct. 3rd, is now being compiled under the direction of the Exposition management. The directory will be arranged according to the numerous consuming groups, listing products, and equipment sold to each group by exhibitors. The compilation will cover all chemical process materials and machinery and the industries for which they are available. Under each product or group will be listed the various exhibitors who manufacture the article in question with any particular information about the individual products of the different manufacturers.

The Chemical Exposition directory will be compiled primarily to help buyers who come to the Exposition in search of various materials or equipment. It is believed that it will be particularly valuable to foreign buyers who are not acquainted with the names of the American manufacturers or with their products. The volume when completed is expected to make several thousand pages which will preclude its being printed for general distribution to visitors. It will be made up in loose-leaf form and held by the management for consultation when inquiries are received as to sources of supply at the Exposition.

THE STUDENTS' PROGRAM AT THE TENTH EXPOSITION OF CHEMICAL INDUSTRIES, GRAND CENTRAL PALACE, NEW YORK, SEPT. 28 TO OCT. 3

The morning sessions will begin at 9:00 A.M. with one general address to all the students with the following subjects and speakers:

TUESDAY: "The Application of Research to Industry," Dr. Arthur D. Little.

WEDNESDAY: "Sources of Information for Chemists and Engineers," H. E. Howe, Editor, *Industrial & Engineering Chemistry*.

THURSDAY: "Buying and Selling the Products of Chemistry," William Haynes, Pres., "Drug & Chemical Markets."

FRIDAY: "The American Chemical Industry of Today," Dr. Charles H. Herty.

After the general address has been delivered the students will separate into two groups (in separate rooms). There will be two distinct programs carried out as follows:

Group I

This group will comprise students who have knowledge of elementary chemistry.

TUESDAY, Sept. 29th—10 to 12 A.M.

Lecture: "DISINTEGRATION: Crushing, Grinding and Pulverizing," Arthur S. Taggart, Columbia University.

WEDNESDAY, Sept. 30th—10 to 12 A.M.

Lecture: "MECHANICAL SEPARATION: Separation of Solids from Liquids; Filtration, Grading, Classifying, Settling and Thickening," Arthur Wright, Filtration Engineers, Inc., New York. "Solids from Solids; Solids from Gases; Centrifugal Separation; Dust Collection and Precipitation." Speaker to be announced.

THURSDAY, Oct. 1st—10 to 12 A.M.

Lecture: "SEPARATION WITH PHASE CHANGE: Evaporation, Distillation and Drying." Theory—W. A. McAdams, Massachusetts Institute of Technology. Practice; Discussion of Apparatus—Otto Mantius, New York.

FRIDAY, Oct. 2nd—10 to 12 A.M.

Lectures: "HANDLING OF MATERIALS: Vertical, Lateral, and Horizontal Transportation," A. E. Marshall, Corning Glass Works, New York. "MATERIALS OF CONSTRUCTION: What to use, when, where and why." "Ceramic Materials to Use in Chemical Plant Construction," Ross C. Purdy, Secy., American Ceramic Society, Columbus, Ohio. "Metals, Alloys,

Plastics, Wood, Fibres, and Fabrics as Materials of Construction," W. S. Calcott, E. I. duPont de Nemours & Co., Wilmington, Del.

SATURDAY, Oct. 3rd—Examinations.

Group II

This group will comprise advanced students and those having a more extensive knowledge of chemistry and chemical engineering.

TUESDAY, Sept. 29th—10 to 12 A.M.

Lectures: DISINTEGRATION: "Some Commercial Applications of Disintegrating Mills," Pierce M. Travis, National Homogenizer Co., New York. "Emulsions and Emulsification," Pierce M. Travis, National Homogenizer Co., New York. "Pulverizing and Grinding," Harlow Hardinge, Hardinge Co., New York.

WEDNESDAY, Sept. 30th—10 to 12 A.M.

Lectures: MECHANICAL SEPARATION: "Separation of Solids from Solids According to Particle Size," Albert R. Reed, W. S. Tyler Company, Cleveland, O. "New Developments and Operation in Thickening and Clarification," Noel Cunningham, Hardinge Co., New York. "Liquids and Centrifugal Separation," W. D. Cleary, DeLaval Separator Co., New York. "Separation by Sedimentation," H. N. Spicer, The Dorr Co., New York.

THURSDAY, Oct. 1st—10 to 12 A.M.

Lectures: SEPARATION WITH PHASE CHANGE: "Dryers and Drying as Used by the Chemical and Associated Industries," F. E. Finch, Ruggles-Coles Engineering Co., New York.

FRIDAY, Oct. 2nd—10 to 12 A.M.

Lectures: UNUSUAL MATERIALS OF CONSTRUCTION: "Heat Resisting Alloys," Arlington Bensel, Victor Hybinette, New York. "Pyrex Glass," A. E. Marshall, Corning Glass Works, Corning, N. Y. "Bakelite," T. S. Taylor, Bakelite Corp., New York. "Lacquers as Protective Coatings," Arthur Orr, Commercial Solvents Corp., Terre Haute, Ind. HANDLING OF MATERIALS: "Conveying with Steel Belting," James S. Pasman, Sandvik Steel, Inc., New York.

Motion Picture Program

"Quarrying and Shaping Slate; Nature's Product of Manifold Uses." 2 reels—Courtesy National Lime Association (speaker accompanied).

"Copper Smelting and Brass Manufacture." 4 reels—Courtesy Anaconda Copper Mining Co.

"The Tight Barrel" from tree to finished product. 1 reel (20 min.)—Courtesy Associated Cooperage Industries of America (speaker accompanied).

"Lime: Its Manufacture and Use in Industry and Construction." 1 reel—Courtesy B. & O. R. R. and National Lime Assoc.

"Producing Cane Sugar in Cuba." 2 reels

"Producing Beet Sugar in the West." 1 reel

"Chemistry beyond the Microscope." 1 reel

"Ancient and Modern Papermaking." 2 reels

"A Brief Sketch of Thomas A. Edison." 3 reels

"Thomas A. Edison Visits Some Chemists." 1 reel—Courtesy of General Electric Company.

"A Trip through Filmland."—Courtesy of Eastman Kodak Co.

Relativity Theory Falls if Experiments True, says Einstein. The Einstein theory of relativity must fall or at least require radical modification, if the experiments performed at Mt. Wilson, in California, by Prof. Dayton C. Miller, of Cleveland, are correct, is the opinion of Prof. Albert Einstein himself, expressed in a communication from him to *Science Service* which has just been received.

"If Dr. Miller's results should be confirmed," he says, "then the special relativity theory, and with it the general theory in its present form, falls. Experiment is the supreme judge. Only the equivalence of inertia and weight remain, which would lead to an essentially different theory."

The Mt. Wilson experiments were intended to show the motion of the earth through the ether in space by which light and other radiations are supposed to be transmitted. When originally performed by Prof. A. A. Michelson, now at the University of Chicago, and when repeated by Prof. Miller at Cleveland, no appreciable result was obtained. When Prof. Miller repeated it at Mt. Wilson, which is about a mile high, he obtained a marked effect, which seems to vary with the altitude.

According to Dr. Ludwik Silberstein, of the Eastman Kodak Company's Research Laboratory at Rochester, this indicated that the ether was dragged around by the earth at low altitudes, but drifted by at higher ones. According to Prof. A. S. Eddington, of Cambridge University, England, such an effect would produce a difference in the position of stars as observed from sea level and mountain observatories, and no such difference has ever been observed. Dr. Silberstein answered this objection by the statement that the ether undergoes a peculiar kind of deformation, but Prof. Einstein does not agree with him.

"I cannot share Dr. Silberstein's conception in case the experiments are correct," says the Berlin savant. "He means that with a theory of a deformable but fixed ether the known phenomena can be explained. This, however, is not so. A theory such as that is absolutely inconsistent with the positively proven astronomical aberrations. No theory exists, outside of the theory of relativity and the similar Lorentz theory, which, except for the Miller experiment, explains all the known phenomena up to date.

"Under these circumstances nothing remains but to await more complete publication of Miller's results. Then it is to be hoped that a correct decision will develop."
—*Science Service*

Chemical Digest

OVERLAPPING OF HIGH-SCHOOL AND COLLEGE CHEMISTRY —AN ABSTRACT

In his recent study, *The Junior College*, Professor Leonard V. Koos reports a detailed examination of certain courses offered to students in the upper years of the high school and to freshman and sophomore college students. The chapter, Overlapping in Chemistry,[1] reports the results of his examination of courses in chemistry. In addition to the importance of this work for clarifying the field of the junior college, it makes an important contribution to the problem of correlating high-school and college chemistry. The present article is an abstract of the chapter.

The larger aspects of the method followed in this study are (1) making inquiry of heads of departments of chemistry in schools of the types concerned and (2) the analysis of the materials reported as constituting the courses under consideration. Information touching the first point was obtained from 26 high schools distributed among 6 north central states and from 41 colleges distributed among 11 states. The institutions were selected at random from standard approved schools with the single exception that all the high schools concerned are in cities with population of 10,000 or over.

Particular significance is attached to the time allotment and to the classification of students studying chemistry in each type of institution. All courses in both high school and college extend through a full school year. The median numbers of minutes per week in recitation (or lecture) are 135 and 150, a difference of 15 minutes per week in favor of the college. The difference in time spent in the laboratory is greater, the respective median amounts being 160 and 225 minutes. Adding the median for recitation and laboratory gives weekly totals of 295 minutes in high-school and 375 in college courses, a total weekly excess for the colleges of 80 minutes or 27 per cent. The median number of periods in recitation and laboratory are the same in both institutions, being respectively, 3 and 2. The data on classification of students show that high-school students taking chemistry are predominantly seniors and that the college students are predominantly freshmen.

The second larger aspect of the study relates to a comparison of the content of the courses offered in the high schools and the colleges. Replies

[1] Koos, Leonard Vincent, *The Junior College*, Research Publications of the University of Minnesota. Studies in Education, No. 5. (In two volumes.) Minneapolis, May, 1924. Chapter XXXIII.

from the teachers in the schools studied establish the fact that course content is that of the text-book and laboratory manual selected for use. Most of the teachers stated that they followed the text and manual with but little omission. The replies indicate further that comparatively small use is made of supplementary materials. Only about half of the high schools and one-fourth of the colleges require special reports. Such class exercises as special problems, projects, visits to industries, etc., are not common in either unit, but are more often resorted to in high schools than in colleges. A comparison of the course content is therefore a comparison of the content of the texts and laboratory manuals the use of which was reported in the blanks of inquiry.

The text by McPherson and Henderson was in use in 16 of the 44 colleges from which information was obtained and the one by Alexander Smith was used in 17. The content of the typical college course may therefore be determined by analysis of these two books. The high-school text by Brownlee and others was used in 14 of the 26 high schools. Other texts reported twice or oftener are Dull's *Essentials of Modern Chemistry*, 4, McPherson and Henderson's *Beginning Chemistry*, 3, Smith's *Elementary Chemistry*, 3; and Newell's *General Chemistry*, 2. The three selected for analysis are Brownlee's, McPherson and Henderson's, and Smith's. The two last named were selected in preference to Dull's owing to the fact that the same authors' college texts were represented in this study. Hereafter the five texts selected for analysis are referred to by number in the following order: I, McPherson and Henderson's college text, II, Smith's college text, III, McPherson and Henderson's high-school text, IV, Smith's high-school text and V, Brownlee and others.

A detailed report of the analysis is given in table form.[2] The two larger headings under which the content has been divided are seen to be (*a*) the common chemical elements and (*b*) the other subdivisions. For each text and for each group of texts are shown the numbers of lines[3] devoted to each of the several subdivisions and the percentages these numbers are of the total content. For instance, occurrence of the common elements receives 503 lines of attention in Text I or 1.95 per cent of the total volume.

Interest will center upon a comparison of the sizes of the books and upon the absolute and the relative amounts of space allotted to each of the topics. The table gives this and it gives in the last four columns the average number of lines devoted to each topic by both the college and high-school texts. It gives also the average of the total number of lines in the college texts and in the high-school texts and the per cent which the average number of lines given to each topic is of these totals. The table shows, for example, the

[2] *The Junior College*, Table CLXXIX.

[3] All lines reported have been reduced to the same basis in order to make the data readily comparable.

average number of lines in the college texts to be 27.343. It shows also that the average number of lines given to occurrence of common chemical elements is 440. This is 1.62 per cent of the average number of lines in the college texts.

The columns setting forth the content of Texts I and II (the college texts) indicate that there are some appreciable but no notable differences between them. Similarly Texts III and IV show marked similarities and no notable differences. Text V is unique in some features, particularly as respects its length. The total number of lines in this book is 69 per cent of the average number of lines in the college texts. Corresponding percentages for each of the other high-school texts are but 51 and 54. It should be remembered in this connection that Text V was used in 14 of the 26 high schools represented.

As was to be anticipated the average columns show that the college texts devote more lines to most of the subdivisions of chemistry than do the high-school texts; the exceptions are, uses of common elements, organic compounds, questions, and summaries and restatements. The differences shown by the percentage columns are much less marked. Except for the somewhat larger proportion of space given to preparation and properties of compounds and to principles, etc., by college texts and for the somewhat larger emphasis, by high-school texts, on uses, organic compounds and pedagogical devices, these columns are closely similar. Under the subdivisions, processes, principles, laws and definitions are included what may be termed the theoretical portions of the course. These divisions constitute 41.35 per cent of the college course and 37.34 per cent of the high-school course. The theoretical portions of the college text can thus be said to exceed those of the high-school texts by 4 per cent—an appreciable, but hardly extraordinary difference. It is clear from the table that the similarities in the content of the high-school and college texts greatly exceed the differences.

As the text-book dominates the content of the class-room work, so the manual determines the laboratory activities. This is evidenced by the fact that 34 of 41 colleges and 20 of 26 high schools report no supplementary manuals. In almost all instances the manuals intended to accompany the text-books reported are the ones used. On this account these manuals were selected for analysis. They are designated by Roman numerals corresponding to those assigned the texts by the same authors.

Some notion of the similarity of the manuals is indicated by the fact that of a total of 99 titles of experiments, 79 were found in Manual I and 85 in Manual II. Manual III, the first of the high-school group, contained 88; Manual IV, 73; and Manual V, 66.

As in the case of the text-books, the differences between the high-school and college manuals is chiefly in the extent of the treatment. The college

manuals usually included a larger number of what may be termed sub-experiments under each experiment title. This difference is illustrated by reference to the experiments with sulfur and sulfur compounds. There is in all the manuals a total of 6 different experiments with sulfur and its compounds. Each of these, except sulfides, is represented in all manuals. This experiment did not appear in one of the manuals prepared for college use. The college manuals contained an average of $40^1/_2$ portions, or sub-experiments, while the high-school manuals contained an average of but $23^1/_3$ sub-experiments. This illustration indicates that although there is much overlapping in the larger features and content of the experiments introduced, the more extended detail in the college manuals means a more thoroughgoing experimental exploration of the fields represented.

The amount of overlapping may be further illustrated by a comparison of the amount of space (number of lines) in each manual devoted to experiments which are contained in all manuals, The striking similarity is illustrated by the fact that 71.70 per cent[4] of the lines in Manual I are devoted to experiments contained in all five manuals and that 73.48 per cent of the lines in Manual II are devoted to experiments contained in all five manuals. The average of these two percentages, 72.59 is a measure of the extent to which the experiments of the college manuals are common to all those examined. Corresponding percentages for the high-school manuals are: Manual III, 64.63 per cent; Manual IV, 69.76 per cent and Manual V, 68.67 per cent. The average of these, 67.69, is a measure of the extent to which the experiments of the high-school manuals are common to all those examined. Further extension of this examination shows that 99.07 per cent of all the lines in the college manuals are devoted to experiments contained in one or more of the high-school manuals and that 95.21 per cent of the lines in the high-school manuals are devoted to experiments contained in one or the other of the two college manuals. In other words, less than one per cent of the material of all the manuals is peculiar to those for the college and less than five per cent of all is peculiar to the high-school manuals. A remarkable degree of overlapping is shown by the large percentages of common materials found in both of the college and all three of the school manuals. The overlapping is in fact so large that the laboratory work offered at each of the two levels cannot be far from identical in major aspects.

A comparison of the total number of pages of textual and supplementary material shows that the college course is somewhat more extensive.[5] The median number of pages covered by the two types of institutions per 60-minute hour of recitation and lecture are 9.2 and 7.9 or a median difference

[4] The percentages in this paragraph are taken from *The Junior College*, Table CLXXXIII, p. 487.

[5] *The Junior College*, Table CLXXXIV, p. 489.

of 1.3 pages in favor of the colleges. However, the time allotment for the college course is greater. When it is recalled that the high-school course constitutes usually but one-fourth of the work taken by the student during a single year and that the college course constitutes a third, this difference appears less consequential. The evidence suggests the conclusion, that the demands made upon high-school students are but slightly less rigorous than those made upon college students.

As respects method of conducting the courses and size of recitation sections, the courses at each level are markedly similar. The chief difference in method is that there is more lecture and quiz and less recitation in college than in high school. The median sizes of the recitation sections are 21 and 25 respectively, in high school and college. The median lecture sections contain 20 and 30 students.

The evidence obtained from the analysis of texts and laboratory manuals, from the measures of materials covered, and from the analysis of methods used, indicates that the courses offered at the two levels are markedly similar. If the materials presented in high-school courses may be presumed to be secondary in character, there is relatively little in the first year college course that is not purely secondary. Moreover, if a student takes the course in general inorganic chemistry in college after having had the high-school course, which is often done, he is repeating almost all of it. Even in that relatively small proportion of higher institutions where such a student enters upon a course in general inorganic chemistry presumed to be administered to those who offered the high-school unit for admission, there must be a large amount of repetition.

This study affords a factual basis for the statement that the high-school course in chemistry is but an abbreviated college course and it indicates how the abbreviation has been made. Its significance extends in both the fields of administrative and curricular reorganization. S. R. POWERS

SYNTHETIC PRODUCTS

Our system of education has been *systematized* to such an extent that the process of school training has become mechanical. The synthetic products of this system, themselves, are afflicted with what might be called intellectual inertia. As this term implies, they have no disposition to move or act of their own accord. They have been put through the educational machinery and appear on the market as finished products. Quoting Prof. Raymond Pearl of Johns Hopkins University,[1] "It is now quite possible, in fact it probably has been done, for a boy to go straight

[1] "The Reading of Graduate Students," *Sci. Mo.*, **21**, 34–44 (1925).

through from his letter blocks to his Ph.D. with precisely the same kind of coöperation in the enterprise on his part that a sardine furnishes to the business of his translation from the state of innocence and freedom of his birthplace to the diploma-bearing tin on the grocer's shelf. All that is requisite is a certain self-effacing conformity to the series of propulsive mechanisms." He adds: "without interfering in any important way with the smoothness of the established methods of manufacturing doctors of philosophy, and without curtailing the output of this commodity, it is desirable, and should be possible, to make the graduate student take a more active personal interest in the process than the sardine may be presumed to."

And what of Huxley and his teaching? Huxley, who advocated the study of science for its cultural value? Prof. H. E. Armstrong[2] says that "No student today studies at the university with any other object than that of getting on in life: the courses are directed to professional, not to cultural, moral ends." When this same student, a synthetic Ph.D., begins his career he fully expects to "get on in life" in much the same way as he got through school!

This attitude on the part of the student is not attributable to the system of education alone; the instructors themselves are at fault. Like all manufacturers they take pride in the product turned out and do what they can to keep the machinery working smoothly.

How, then, can a student be encouraged to do something for himself? To know something of his science in its relationship to other sciences and to life in general and thus to benefit by its cultural side? Prof. Pearl outlines a course of reading which he has prepared for his graduate students. He divides this course into three parts: (A) The Nature, Meaning, and Method of Science, (B) The Conduct of Life, and (C) Biometry and Vital Statistics. The first two divisions are general in their scope and are designed to meet the needs of graduate students in any field; the third is more specialized and is intended primarily for students in his own particular field. Prof. Pearl has not presented a mere bibliographical list. Each title included is accompanied by pointed and sometimes humorous comments. Such a reading course should accomplish two things: it should discover to the student the cultural possibilities of his science and, at the same time, stimulate him to take a somewhat more active interest in his own development. W. R. W.

[2] "The Future Science of the Schools," *J. Educ. and Sch. World*, **57**, 482–8 (1925).

SUBSIDIZING ACCOMPLISHMENT

The incentives to social attainment in college life far overbalance those to scholastic accomplishment. The immediate rewards of the former are ever choice morsels for the student who is first of all a social human being. But what inducement is there to outstanding scholastic activity other than the ultimate value of knowledge for its own sake? Under existing conditions there is none. It would seem, then, that in order to subsidize scholastic attainment on the part of the student, an immediate recompense must be offered.

Frank Aydelotte in a recent article[1] strongly advocates the general adoption of an "Honors" system. Speaking of students generally, he says, "The standardization of the instruction of these masses has been carried to the place where it resembles the Federal Reserve system. If you have an academic record of certain grades in certain courses in a certain recognized college, you can cash it in any other recognized college just as you can collect a check through any Federal Reserve Bank. Our intellectual values could not possibly be represented correctly by this credit system." Freedom of choice is given to the student in social activities, he points out, but "in studies on the other hand the virtue most in demand is docility." He favors an "extension of undergraduate freedom from the personal to the intellectual sphere." Swarthmore is cited as an example of the operation of this system. Here are given two degrees, one with "Honors" and one without. At the end of the second year the student is permitted to make his choice provided, of course, that he has previously proved his ability.

James H. Rogers offers a similar suggestion in *School and Society*.[2] He would greatly encourage the "Honors" group while "the students of the lower group would be treated as on probation; tolerated, but not encouraged to continue; and if they insisted on remaining in college, they would be asked to pay the expense of their instruction." He continues, "Healthy and severe competition to get into the 'Honors' group and to remain there would be inevitable. . . . . Intellectual apathy would largely disappear, taking its departure along with that group of worthless students who at present claim to so little purpose the time and energy of the teaching staff, who ruin the morale of the entire student body and who provide the scandals which give such extensive advertisement to our colleges and universities."

One may question the efficacy or the advisability of the solutions offered, yet the problem discussed remains a vital one and these two articles at least furnish food for considerable thought. W. R. W.

[1] "Honors Work in College," *Progr. Educ.*, **2**, 135–8 (1925).

[2] "Revolutionizing College Environment with an Honors System," *Sch. and Soc.*, **22**, 127–32 (1925).

ABSTRACTS

Natural Science by the Experimental Method. JOHN F. WOODHULL. *Gen. Sci. Quart.*, **9**, 256–9 (1925).—The scientific department of the New York College for Training of Teachers is making a study of the question of whether it is practicable for common schools to give science lessons by the experimental method in every grade from the first year of the primary to the last year of high school. Apprenticed teachers from the college are put in charge of the work in order to make conditions as nearly like those in the public schools as possible. In the high-school department systematic scientific instruction is begun for the purpose of developing careful habits of experimenting, observing and reasoning. The experiments are simple and the pupils are taught to construct their own apparatus.

Teaching science by the experimental method prohibits covering as much of the subject as is mapped out in the usual high-school course. The habit of cramming all the facts of the text-book of science should be as loathsome to the teacher as to the pupils. The business of the school is to show the pupil how to study. To this end, quantity must be sacrificed to quality. The amount of subject-matter must be reduced to half that which the pupils at present attempt to grasp. Too much of science teaching is beyond the comprehension of the pupil. Patience and love for the work are the most essential qualities for the teacher. With these and freedom from unnecessary restraints, science may be taught in the common schools by the experimental method. W. R. W.

An Inexpensive Footlight Dimmer. W. G. WHITMAN. *Gen. Sci. Quart.*, **9**, 270–1 (1925).—When amateur theatrical performances are given in the school hall the science instructor is often called upon to act as electrician. There may be a call to have lights gradually decrease in intensity. This can be done with material at hand in the laboratory.

The essential device used to reduce the voltage through the lights is a salt cell connected into the circuit. Place a copper plate several square inches in area in one end of a hard rubber photographic tray which is fixed in place and which should be about 15 inches long. Another copper plate is fastened to a wooden handle to facilitate moving it back and forth in the tray. One wire from the source of the current goes directly to the footlights while the other goes to the fixed copper plate in the salt cell. The wire from the movable copper plate goes to the footlights to complete the circuit. Pour 3 per cent solution of sal ammoniac or sodium chloride in the tray to about one inch depth. With the circuit closed and the metal plates close together the lights will burn with full power but the brightness decreases as the plates are separated.

W. R. W.

Chinese Camphor and Camphor Oil. P. L. BRYANT. *China J. of Sci. and Arts*, **3**, 228–34 (1925).—Although much has been written on camphor and camphor oil, most of the published work has been done on Formosan and Japanese products, which differ materially from those of China. So far as per cent of constituents in the oil is concerned, China camphor is identical with that of Formosa but Chinese camphor oil is not.

The Chinese are known to have used borneol or Borneo camphor, a substance closely akin to ordinary camphor, in burial rites long before the first mention of camphor in literature. In practice, camphor is found as a solid in trees in so slight an amount that its appearance in commerce from that source is negligible. The real source of camphor is the steam distillation of chips of the trunks of trees, preferably more than 100 years old.

The still consists of an iron pot placed over a brickwork oven. Upon the pot is put an inverted wooden tub with a manhole in the top and one down low on one side. The former serves to introduce the chips and the latter to withdraw the spent wood. Between the pot and the inverted tub is a grating that lets the steam through but keeps the chips from falling into the boiling water in the pot. The condenser is a long, narrow, shallow box with partitions, covered with a lid built up at the sides and ends to form a shallow trough in which the water is allowed to flow. The steam volatilizes the camphor and camphor oil in the chips and this is later condensed in the box. The oil is filtered through bamboo screens. Most of the stills are made small through the mistaken idea that a small still multiplied by 5 takes less coal than one five times as large. The still being iron, catalytic action occurs to break up the oil composed of terpenes. The distiller's chief tool is a shallow, circular, dipper in which, from time to time, he catches a little of the oil flowing from the condenser. This oil he pours out as far as possible and cools the small residue in the dipper. This he flows back and forth to see whether minute flecks of camphor are visible in the few drops of oil. Thus the

Chinese distiller separates the fractions of oil containing camphor from the more barren portions.

Camphor thus obtained contains about 7 per cent of oil. It is shipped from China in cases of four tins, which average about a picul (133⅓ lbs.) each. No adequate analysis of Chinese camphor has ever been made and it offers a field to the chemist that presents several problems, one being to determine how much of the residual pitch and polyterpenes is due to the iron in the stills. W. R. W.

Significant Progress in Research in Photography. C. E. K. MEES. *Ann. Am. Acad. Political and Soc. Sci.*, **119**, 10–2 (1925).—Research in photography covers the whole process of photography and falls naturally into two divisions; one dealing with the preparation of the sensitive materials and the other with their use. The negative material used in modern photography consists of a suspension of crystals of AgBr in gelatin, this being known as an emulsion. It was soon suggested that the photographic properties were probably connected with the distribution of the different sizes of crystals in the emulsion and this was confirmed by subsequent research. Work on the nature of sensitiveness and its relation to distribution of crystal sizes has been going on since 1920 and great progress has been made in the field. An organized attack has been made on the photographic properties of gelatin, a field in which the great difficulties of colloid chemistry have made progress quite slow. A study is now being undertaken on the conditions of precipitation in relation to dispersion of the grains obtained and, after continued work for a number of years more, a general solution of the theory of emulsion making may be expected. The ultimate returns from research to industry will come not from these immediate services but from fundamental investigations of the type cited. W. R. W.

The High School. EDITORIAL. *Educ. Rec.* (*Quebec*), **45**, 1–6 (1925).—Professor Stephen Leacock of McGill University speaking recently at Moncton N. B. said "I do not believe that education is as sound in either the United States or Canada as it was 25 years ago, and it is largely due to inclusion of subjects which are irrelevant and unteachable in the curricula of the University."

Hon. H. A. L. Fisher, former Minister of Education in England, regards the tendency in high schools as one of superficiality. The question is one of the most important that educators have to consider at the present time. High schools exist for the definite training of a much larger number than ever enter the university and the high-school courses are much less elective than those of the University. With the increasing complexity of modern business, commercial and industrial life, every interest under the sun has been demanding representation in the high-school course of study. To relieve the demand in connection with industrial trades the government everywhere had to found technical schools. The charge of superficiality is not founded if applied to every school everywhere, but the necessity for a policy that will enable the high school to perform its true function remains. W. R. W.

Tissue Transplantation. W. NAKAHARA. *Am. Mercury*, **5**, 456–8 (1925).—Because of the growing importance of a knowledge and application of endocrine glands and secretions there is much real and bogus discussion about gland transplantation. Unsuccessful transplantations were once supposed to be due to a disturbance of blood supply. Ehrlich explained failures on the hypothesis that proper food for foreign tissues was lacking in the host. At present a permanent union of parts of different species cannot be brought about under ordinary conditions among warm blooded animals. A tissue of an individual can be grafted on another part of his own body. If grafted on another individual it will survive if the host has a similar genetical make-up, as in the case of brothers and sisters. SY.

Individuality and Uniformity in Education. J. L. MCCONAUGHY. *Sch. and Soc.*, **21**, 759–67 (1925).—Higher education today tends toward mass production, a uniformity of curriculum for all students and similarity of product for all colleges. Individuality is being lost because we think of the "average." Democracy needs emphasis on individuality and individual development. The college should be small so that the student's personality is not submerged in the group and he must be inspired in the Christian spirit of unselfish service. Admission hurdles should be discarded as soon as a test can be discovered which will show the candidate's ambitions. Decreasing use of the lecture method, increasing recitations, frequent quizzes, are of doubtful value for stimulating the intellectual life of an able student. Compulsory scholarship is not necessarily better, riper and more certain than that which is free. Freshmen deserve the best teachers in college. Juniors and seniors should be allowed great latitude. "Honors" courses should be encouraged. SY.

Jacques Loeb. PAUL DEKRUIF. *Am. Mercury*, **5**, 273–9 (1925).—An appreciа-

tion of Loeb and his work. Loeb worshipped Copernicus and Galileo because they demonstrated their theories. Theories and histories of paleontology, anthropology, and evolution, L. considered bunk because one cannot experiment with the past. Nothing had any standing with him unless it could be verified in the laboratory. If sea-urchin eggs could be fertilized with something else than sperm, then it should be possible to do it in the laboratory. Loeb's salt solutions actually did become the fathers of sea-urchins. Sy.

War Paint. H. TETLOW. *Am. Mercury*, **5**, 285–90 (1925).—This refers to cosmetics and includes a brief history of manufacture and use. The origin, manufacture and use of modern beautifiers is given. The French translation of "face powder" is "poudre de riz." Rice starch or flour is too harsh and not used. Face clay or mud has no legitimate use. There is no substitute for soap, hot water and elbow grease as beautifiers. Sy.

New and Rapid Method for the Removal of Phosphates in Systematic Qualitative Analysis. L. J. CURTMAN, C. MARGULIES AND W. PLECHNER. *Chem. News*, **129**, 299–301, 315–7 (1924).—After the removal of the Cu-Sn group by H_2S, boil off the excess H_2S, add 2 g. NH_4Cl, 0.2 g. of asbestos and 10 cc. of $ZrOCl_2$ soln. contg. 500 mg. of Zr. Add the $ZrOCl_2$ dropwise while stirring vigorously. Make alk. with NH_4OH and boil 2 min. Neutralize and add 10 cc. of 3 *N* HCl in excess. Boil 3 min. and filter while hot. In this way all PO_4 is pptd. as $ZrOHPO_4$ and all but 15 mg. at the most, of the excess Zr is pptd. as $Zr(OH)_4$. About 10 mg. of Zr may be obtained in the pptn. of the Fe and 5 mg. with the Al when the scheme of analysis recommended by Baskerville and Curtman is employed. This method of pptg. PO_4^{---} is applicable to any scheme of qual. analysis. Full details are given. W. T. H. (*C. A.*)

College Curricula and Social Institutions. HOWARD TAYLOR. *Sch. and Soc.*, **21**, 731–6 (1925).—Although many changes have been made recently, very little has been done to reorganize the college course to meet the social needs of today. There is much confusion in regard to the basic requirements of the liberal arts curriculum. Practically the only subject, which all agree should be required of freshmen, is English. Opinions and traditions have been the most potent factors in developing college curricula. The doctrine of formal discipline has had widespread acceptance in the past. Sometimes subjects are placed in the required list in order to prevent the disappearance of the department in question, the department having held a strong position in the past. Many students would never elect Greek, Latin, or mathematics. These are kept alive because they are in the required list, and they are in this list because of tradition and the doctrine of formal discipline. A popular and promising addition to the required subjects is a type of course which may be classed under four heads: First, courses designed to adjust the student to college environment (College Aims, Orientation Lectures); second, courses that give a historical background to present-day civilization (Contemporary Civilization, Historical Introduction to Political Science and Economics); third, courses presenting problems of American citizenship (Problems in Citizenship, American Citizenship); fourth, courses designed to train students in thinking (Introduction to Reflective Thinking). To further improve the usual arts curriculum, author suggests abandoning the fixing of freshman and sophomore requirements in terms of organized subject-matter (natural science, language, math., history). The required courses should be determined from the point of view of the student and of society. For example, the knowledge and habits acquired in a freshman chemistry course are valuable and necessary for a worker in chemistry but have little value for great masses of people. Selection of required courses should be based on the five institutional organizations of society, the home, the school, the state, the church, the vocation. All college education should include courses explaining the history and function of these institutions. Sy.

The Business Value of Chemistry in Education. JOHN MALPAS. *Chem. News*, **131**, 69–70 (1925).—There can be no doubt that the commercial side of chemistry is much more prominent than the chemical side. In modern life the applications of chemistry are countless and in many cases the laboratory is the brains of the factory. Chemical discoveries have decided monetary value. Several incidences of this are cited, the most remarkable of these being the discovery of alizarin and indigo.

The chemist is an important factor in the war on waste. An unprofitable industry may become financially stable because the obnoxious by-products have been made a source of revenue to the industry.

Chemistry is also an excellent field in which to lay the foundations for mental development—a side that is often lost sight of where chemistry is concerned. It teaches application, observance of details, method, regularity, and accuracy. In business life, observation is the golden key, but it means much more than merely seeing. It is an

intelligent understanding of men as well as of things. The importance of accurate observation cannot be over-emphasized.

The article is concluded by a quotation from the *North American Review* of March, **1896,** which states that the country which has the best chemists will in the long run be the most prosperous and the most powerful. W. R. W.

Chemical Engineering. W. K. LEWIS. *Bur. of Educ. Bull.*, **5,** part 4, 21–4 (1925).—In the industrial growth of a new country, chemical industries other than metallurgical are the last to develop, because their existence is possible only where a strong transportation system is available to supply raw material and distribute products, where mechanical industries can be relied upon for equipment and where electrical developments exist to furnish and distribute power. Therefore the rapid expansion of the chemical industries in this country did not begin until the eighties. Prior to this there was no demand for men with chemical engineering training.

The concept of the chemical engineer has changed since that time. In the announcement of the first course offered in this country it was stated that "the chemical engineer is not primarily a chemist but a mechanical engineer." His function was the construction of chemical plants and equipment but did not include the development and operation of chemical processes. The first important forward step in reorganizing the subject-matter of the curriculum was taken in 1907. Prof. W. H. Walker, of the Mass. Institute of Technology, realized that the chemical engineer must be primarily a chemist though thoroughly trained in the fundamentals of engineering. The next important development was the establishment, in 1910, of a course of study in chemical engineering at Columbia University. Other developments are cited.

In no other branch of engineering is research of more importance and the land-grant colleges have maintained the leadership in training men for research work in the chemical industries. There are in engineering education two schools of thinkers—those who believe that the sciences should be taught as abstract entities, unrelated to practical things, and those who would teach them by means of their applications only. Chemical engineering is by no means standardized but offers unusual diversity of character in a single field. To meet the exacting requirements of this broad demand upon the profession, our institutions are developing a new standard of engineering education consisting of a saner balance between theory and practice. W. R. W.

Value of Industrial Research. U. S. BUREAU OF STANDARDS VISITING COMMITTEE. *Chem. News*, **131,** 6 (1925).—The committee cites examples of the value of basic research in the past and believes more to come in the future. Industrial research is also held essential to prosperity. The value of basic research, aimed at the acquisition of knowledge without immediate utilitarian objectives, is emphasized in the report of the committee. Attention is called to the value of industrial research. Numerous examples of savings effected by such research at the Bureau of Standards are given. Both types of research are essential to the welfare and industrial prosperity of the nation. The economies resulting from them are often very considerable and are necessary if America is to maintain its present high wage rates and high standards of living in the era of intense industrial competition upon which the world now appears to be entering. The desirability of having research conducted by a national institution is emphasized. Its value depends on the extent to which the results are utilized rather than upon the cost of the work, and a national laboratory such as the Bureau of Standards can afford to give its results freely to all who may profit by them, whereas a private laboratory cannot always be expected to do so. The report also dealt with the wide range of the activities of the Bureau and is convincing evidence of the useful work in which it is engaged. W. R. W.

Metric System in Schools. M. H. HARRIGAN. *J. Natl. Educ. Assoc.*, **14,** 170 (1925).—Quoting Chas. H. Judd, of the Department of Education of the University of Chicago, "In the metric system the units of volume, length, and weight are all developed out of the same fundamental standards. This unification of all weights and measures was never before scientifically attempted, and its absence from the English system is one of the characteristics which mark that system as primitive in character. Furthermore, the metric system has so arranged its various units that they are easy to use in calculations because they are organized, as are our numerals, into a decimal system. Whatever else is to be said about the metric system it is certainly desirable that American pupils should know these virtues which it embodies."

The question of method and of outlook is of vital importance. The metric system should be taught by itself, and the child accustomed to the feel and look of the metric units. The metric system should be compared with our money system, and the idea of dollar-meter-liter-gram linked up in the child's mind. The pupil should get the world

vision of 55 nations, one after the other, discarding their local measures and adopting the metric system. He should realize the anomalous situation in the United States today. The pupil's attention may be called to the newspaper where day by day there appears reference to metric units. When such a student gets to science work in high school, he will merely continue his knowledge of metric measures, as he weighs in grams and measures in centimeters. W. R. W.

The Teaching of Applied Chemistry. (EDITORIAL.) *Chem. Age* (London), **13,** 51 (1925).—The question of the inclusion of applied chemistry in the curriculum of an honors degree in chemistry attains greater prominence as time goes on. The importance of the subject is illustrated by the fact that the Council of the Institute of Chemistry has just modified one of the rules of the institute whereby those specializing in applied chemistry can gain admission to the associateship without an examination. The teaching of applied chemistry has become firmly established in several universities and colleges but there are many who hold the opinion that it is not the function of a university to give instruction in technical chemistry. With so much pure or fundamental chemistry to be learned the attempt to crowd in a knowledge of works' practice is of doubtful value. More should be done, however, to make the student acquainted with those materials and processes of importance in the chemical industry by laying greater emphasis on those parts of his work which, while of theoretical interest, also have a technical application. Instruction on reactions of fundamental importance might well be illustrated by means of examples of technical value. Many of those undertaking a degree course in chemistry are fitting themselves to earn a livelihood in the chemical industries. There is sufficient pure chemistry involved in the many branches of chemical manufacture to make it possible to draw largely upon these for examples which form the means of inculcating the theoretical side of the subject. In this way the student would be familiarized to a great extent with those processes which he is likely to meet when he enters upon an industrial career. W. R. W.

Technical Libraries. (EDITORIAL.) *Chem. Age* (London), **13,** 52 (1925).—Considerable interest in the organization of technical libraries has been aroused by a paper which appears in a current issue of the *Journal of the Institute of Chemistry.* Every chemical manufacturing firm finds it necessary to equip some sort of library suited to its own particular needs. The chemist must not only keep in touch with present progress in his own section of this wide field, but is very dependent upon the records of the earlier achievements of others.

The really useful library is not, however, a mere collection of the necessary books and journals. It must include a librarian, capable of rendering easily accessible the knowledge stored away in the printed pages. The library in Nobel's factory at Ardeer is an example of such a technical library. In proper hands, a library is as valuable at least as an additional chemist. The modern librarian is specialized in the art of hunting information. The importance of such specialization is recognized in America, and several universities have now instituted courses of lectures expressly for the teaching of this art. W. R. W.

The Atom's Amazing Secret of Power near Solution. G. B. SEYBOLD. *Pop. Sci. Mo.,* **107,** 47–8 (1925).—Dr. T. F. Wall of Sheffield University devises apparatus with extremely powerful magnetic field for disrupting the atom within which incomprehensible power is believed to be hidden, enough in a pint of water to drive the Leviathan across the Atlantic and back.

Atoms consist of nuclei surrounded by electrons whirling about them in fixed orbits with a speed of at least 93,000 miles per sec. If a drop of water were magnified to the size of the earth, an atom would appear the size of a baseball. Magnify the atom to a mile and the electron would be as large as a dining room table. A pea in the center of the table would represent the nucleus. The number of electrons revolving in successive rings or orbits determines the kind of matter. The changing of nucleus or orbits of electrons changes character of element. This has been done with radium and some other elements.

Revolving electrons produce intense magnetic fields. Dr. Wall believes that sufficiently powerful magnetic fields might disturb the orbits so that atomic structure would be broken down and some of its energy released. For a small fraction of a second, his apparatus is capable of permitting an equivalent of 200,000 horsepower to be supplied to the coil. A magnetic field is produced 20 times more intense than ever before known. It is conceivable that instead of the tons of coal we buy every month, we may release the energy contained in a two-pound lump, knowing that there is enough there to heat a large house all winter.

Other scientists are working on the problem of releasing the energy in the atom.

Dr. Wendt of Penna. State College is trying to do it by using a temperature of 60,000 degrees F. By intense heat Prof. Miethe of Germany recently changed mercury into gold by dislodging one of its 80 electrons. Dr. Nagoaka of Tokio University is said to have changed mercury into gold. Dr. Millikan is attempting to discover the secret by studying changes taking place in the stars.

Sir Ernest Rutherford doubts that great stores of energy exist in every element but believes it to be true of radio-active substances only. F. E. GOODELL

Chemical Engineering Aspects of Water Treatment for Railroads. WILLIAM M. BARR. *Trans. Am. Inst. of Chem. Eng.*, **16**, 149–61 (1924).—Formerly, it was the practice for a locomotive to be changed every 150 miles. It was found that great economy could be effected by making the runs as long as possible. One of the most important factors in making long runs is correct water conditions in the boiler. By proper treatment of boiler water it is now possible to run a passenger engine from 600–700 miles without change even in districts where the water is bad. Recently, a mountain type engine ran 993 miles pulling a full tonnage mail train, and made the return run without changing water. Analysis of the water in the boiler showed a satisfactory concentration of salts.

Foaming, due to the formation of sodium salts, and incrusting of injectors and branch pipes is kept to a minimum by the use of as little lime and soda ash as possible when softening the water. Zeolite softeners cannot be used in spite of the fact that they remove practically all the hardness from the water, because of the formation of sodium salts which would increase the foaming in the boilers. Sodium aluminate has recently appeared on the market as a water softener, but its cost is high when compared with that of lime and soda ash. However, the combined use of lime, soda ash, and sodium aluminate gave a total hardness of 70 parts per million as compared with 90 parts per million with the lime soda ash treatment with an increased cost of 10%.

The problem of water softening for railroad use is more complicated than for stationary plants which have a single source of water. The paper also includes a brief discussion of some of the factors involved in designing water softening plants for railroad use. G. B. HEISIG

Refined Sulfurs: Their Manufacture and Uses. C. A. NEWHALL. *Trans. Am. Inst. of Chem. Eng.*, **16**, 163–83 (1924).—At present there is a demand for sulfur which is purer than the crude product obtained from the Gulf Coast. To produce such a product, the crude sulfur is heated to remove the moisture and volatile acids at a temperature high enough to char any organic matter present, but not high enough to convert the sulfur into one of the viscous modifications. The melted sulfur is skimmed to remove the asphalt and wood, and then sublimed into chambers, some of which have a volume as large as 30,000 cubic feet. The finest and fluffiest flowers of sulfur form some distance from the goose neck, the heavier flowers somewhat closer to it, while directly beneath it some of the sulfur solidifies in a solid mass. The relative amounts of light and heavy flowers, as well as the solidified product, vary with the size and temperature of the chamber and the temperature at which the sublimation is carried out. The content of the chambers is carefully separated by the larger refineries into three or more grades: Flowers of sulfur is that portion which has a weight of 30 pounds per cubic foot, and ordinarily has an acidity expressed as H_2SO_4 varying between 0.2–0.5%. The particles are spherical droplets and in the highest grades are free from one another or barely touch. This form makes up about one-half of the sublimed material.

The heavier material is run through a beater or granulator and sold under various trade names depending on the size and density of the particles. The bolted product is known on the Pacific Coast as "Flour Sulfur" or "Powdered Sublimed Sulfur." The air separated product is sold as "Ventilated Sulfur" along the West coast and "Superfine Refined Sulfur" in the East. Some of the names under which the heavy product is marketed are: "Heavy Flowers," "Refined Lump," and "Lump Brimstone." These forms are known under different names in other markets.

If it is desired to make refined brimstone or roll sulfur a small chamber is used and the temperature is maintained near the melting point of sulfur. Sometimes the heavy forms of sulfur from the chamber are melted. The liquefied sulfur in either case is cast in three pound conical sticks, or run into blocks and cooled. The sulfur in the blocks is the rhombic form and contains none of the amorphous modifications, moisture, or acids. It may be reduced to powder and sold to trades desiring 100% rhombic sulfur.

Precipitated sulfur is known to the drug trade as "Magister of Sulfur" or "Lac Sulfur," and is prepared by precipitation from solutions of soluble polysulfides. This form of sulfur is deposited on plants from a lime sulfur spray.

Refined rhombic sulfur is used in manufacturing black powder, in the rubber trade, for agricultural purposes as a fertilizer and insecticide, and for sulfuring foodstuffs.

It is known that the change from amorphous sulfur to the crystalline modification is accompanied by a shrinkage in volume and the evolution of heat. Newhall believes that this accounts for the superiority of flowers of sulfur over the rhombic sulfur when used for sterilizing food or as a dust insecticide or fungicide. This is true even when the particles of the latter are many times smaller than the former. Doran showed that the presence of oxygen is necessary when sulfur acts as an insecticide, and infers that sulfur dioxide is the active agent. Newhall explains this by assuming that sunlight catalyzes the change of the amorphous sulfur to a crystalline modification. The change is accompanied by the shattering of the droplets due to their shrinking, and as a result the smaller particles with the largely increased surface react more readily with the oxygen at the slightly elevated temperature. The acidity of the flowers of sulfur also seems to influence the change. Newhall expresses regret that so few of the sulfur refiners are aware of, or at any rate fail to appreciate the value of, Alexander Smith's researches on sulfur. He believes that much expense could be prevented by applying Smith's ideas.

G. B. HEISIG

Crodon. (EDITORIAL.) *Metal Industry*, **23**, 250–1 (1925).—A process for chromium plating has been developed by Dr. C. G. Fink of Columbia University. The method has been developed commercially by the Chemical Treatment Company of New York. Crodon, the trade name for the chromium plate, is very resistant to the action of corrosive substances and its use will enable a manufacturer to substitute a less expensive, but more easily worked material for those higher priced and more difficultly worked. A valve seat plated with crodon, for example, was found to withstand the action of superheated steam at 190 pounds' pressure for 200 hours. The steam had been previously passed through aluminum sulfate crystals in order to increase its corrosive effects.

The outside of a small piece of steel pipe plated with crodon withstood the corrosive action of flue gases at 2000 degrees F. for 24 hours, while the inside of the pipe which was in contact with the same gases was corroded to such an extent that one-half of its thickness had been "eaten away." Copper strips plated with crodon are broken in two by bending or twisting, but the plate does not peel or flake off. Crodon-plated files retain their cutting power longer than ordinary files. It gives a desirable finish for building hardware, or for plating knives, forks, spoons, etc. G. B. HEISIG

Waimaugu and the Hot-Spring Country of New Zealand. JOSEPH C. GREW. *Natl. Geographic Mag.*, **48**, 109–30 (1925).—In this article some rather interesting chemistry of nature is set forth in non-technical language and more largely by suggestion than by any conscious effort upon the part of the author. Such allusions as "terraces of sulfur, silica, and alum" and "unearthly smells of sulfur * * * hot lakes of extraordinary colors—yellow, blue, pink, green—and brilliantly colored strata along the mountain sides" pique the active mind of any live chemist.

Characteristically superb "Geographic" illustrations contribute their share in the same direction by such descriptive phrases as "vents discharging sulfuric acid fumes" and "beds of hot sulfur, whose crusty surface breaks under the visitor's feet and whose acids eat up shoe soles and clothing."

In his narrative the author describes what is called "soaping a sluggish geyser to make it spout." In doing this "a bag of bar soap" was required. He states that the geyser "went off" within twenty minutes, throwing steam and water one hundred and thirty feet into the air. It is said that too much soaping of a geyser eventually causes it to cease action altogether. Such treatment is only permitted in New Zealand under government supervision. B. CLIFFORD HENDRICKS

Doctor Sunshine. BENJAMIN HARROW. *Good Housekeeping*, **81**, 71 (1925).—Beginning with Pasteur as the father of modern contagious disease-prevention (which diseases are declared upon the decrease) the author follows with the statement that diseases due to foods are increasing. This increase is explained as a result of the substitution of artificial laboratory-made foods for those of nature. In the train of these substitutes go ulcers, cancers, gout, and diabetes. Rickets, the chief topic of this article, is listed in this category of diseases peculiar to civilized people.

Diet regulation is sketched from the days when the number of calories together with a proper proportioning of fats, proteins, and carbohydrates was considered an adequate measure of a menu through to the idea of differentiated proteins, one type furnishing an amino-acid basic for building "hormones," another essential to the existence of "glutathione." ("Glutathione" seems necessary as an aid to the utilization of certain foods by the body.)

Fats are grouped with reference to their vitamin content. Vitamin A, for instance, is shown as a non-antirachitic in contrast with vitamin X which is essential as an ingredient in cod-liver oil when it is to successfully cope with rickets. Vitamin A is distinguished by its success in caring for an eye disease, xerophthalmia.

The subject of the article comes from the paragraphs treating the effect of light upon rickets. Doctor Hess and others have shown that ultra-violet light is a specific cure for rickets. The common effect of vitamin X and ultra-violet light is attributed to their aid in human assimilation of calcium and phosphorus compounds both of which are so essential in bone formation. Foods in common use are much more likely to be short in calcium than in phosphorus.

One of the most interesting features of the article is the report of the findings of Korenchevsky that the diet of the mother before the birth of her child may lead to or help prevent rickets in the child. B. CLIFFORD HENDRICKS

The Correlation of Pharmaceutical and Medical Education. H. H. RUSBY. *J. A. Ph. A.*, **14,** 575 (1925).—It is necessary for schools of pharmacy to form a definite part of the public health curriculum organized by most medical schools so that the pharmacist may be trained similarly to the physician, in order that they may work harmoniously with one another. The writer feels that it will be necessary to establish Graduate Schools of Pharmacy in close connection with our first class medical schools in order to train pharmacists more thoroughly in the biological medicinal agents, synthetic chemistry, and chemical microscopy, in order that he may more adequately take his place in the medical public health program. JOHN C. KRANTZ, JR.

Three-Year Course in Pharmacy. R. A. LYMAN. *J. A. Ph. A.*, **14,** 632 (1925).—The writer urges the course builders in pharmacy schools to include a great many cultural subjects in the pharmacy curriculum. He feels this is necessary to train the pharmacist more adequately in a scientific way and also to give him those additional subjects which will tend to make him more proficient not only as a pharmacist, but as a useful citizen. JOHN C. KRANTZ, JR.

Report on Chemistry. C. H. SALTER. (Cleveland Schoolmasters' Club: Committee Report on Science in Greater Cleveland.) *Sch. Sci. Math.*, **25,** 467–74 (1925).—A report of the study of science teaching in the public schools of Cleveland, as it relates to (1) the objectives of the teachers, and (2) the pupils' concepts of common scientific terms. The sciences included were general science, biology, chemistry, and physics, which were assigned to individual members of the committee for special study. A list of 19 possible objectives of chemistry teaching was submitted to the teachers who were asked to rank them in the order of importance. Lists of common chemical terms were also prepared and submitted to the pupils who had completed a year of chemistry. The list included common terms which might find practical use in the lives of pupils who do not go to college. They were required to define the terms and to indicate whether or not they considered the knowledge useful. The data are presented and the following conclusions drawn: (1) The results show a lack of agreement among the teachers as to the main objectives of chemistry teaching. (2) There is a marked discrepancy between professed objectives and the pupils' actual accomplishments. (3) Chemistry should be taught in the later years of the high-school course. (4) Teachers are efficient in preparing pupils for college. G. A. ABBOTT

The Oneness of the Universe. KARL FUSSLER. *Quart. J. of the U. of North Dakota*, June, **1925.** Address given by exchange lecturer to the University of Manitoba.—F. reviews the brilliant advances in physics and chemistry during the past 30 years especially as it relates to the development of modern conceptions of the nature of matter and electricity. He suggests that a better title might be the "Twoness of the Universe," since the proton and the electron both appear to be fundamental building stones out of which the universe is fashioned. Emphasis is placed upon the essential unity and simplicity and the universal relationship of all things. He sees in this rationality of things evidence of the Divine Creative Intelligence as the all pervading and unifying reality of the universe. A delightfully entertaining and instructive address which must be read in full to be appreciated. G. A. ABBOTT

The Histrionic Nature of Teaching. MARGARET STEPPAT. *J. Educ. and Sch. World*, **57,** 294–6 (1925).—Teaching is not only a science based on physiological, psychological and other principles, but it is a complex art as well. A teacher is more than half an artist in his hold on his class and in his presentation of material. There is no artistry in that teaching which aims merely at purveying information, ill-digested, ill-sorted, and of little use, and there is no artist in that bully who, till recently, maintained order by shouting and repression and whose whole species is now dying slowly more than a mortal death.

Form in teaching approximates, indeed, very nearly to form in acting. It does not impair the comparison that the teacher has planned the material himself, for the theoretical preparation is a separate activity. He will know here how to put his matter into harmonious form, and how to provide for artistic devices which will carry his matter home. He will make a skillful use of surprise, of tension, and relief, of telling phrase, of repetition, of variety and contrast, of concrete representation. What he does plan is not a detached drama which exists first on paper or in his mind and then is enacted completely to his conception, but he arranges for a rising action in the mental experience of his pupils. This will develop from his initial statement, through certain stages of evidence and thought which he consciously provokes and evokes, towards a climax which he has foreseen from the beginning. The teacher's own first progress through this mental experience took place some years ago. Therefore in working through the process again (and again and again with subsequent classes), and perhaps in simulating to arrive at some conclusion with his class, the teacher is a complete actor. His voice, though it remains his own, will frequently, however unconsciously, vary according to the nature of the work, to the state of mind he wishes to arouse, and to the stage in the lesson. This is apart from the mechanical adjustment to the space in which he finds himself. His gestures will be such as assist his pupils to form requisite mental pictures; those which are mere expressions of his own eccentricities are, as far as possible, suppressed. But the teacher also must, like the actor, never descend to a mere perfunctoriness or mechanical repetition of an earlier preformance.

If we become aware that the dramatic artist aims at influencing our will in a definite direction, we become at once antagonistic, and the artistic appeal of the production loses value. In the teacher's case, if his lesson merely entertains for forty minutes, though he has held his audience, we shall be doubtful of our approbation. If by making no personal appeal but by creating interest, his class is stimulated to pursue ideas, and to follow a subject for its own sake, we must withhold criticism. *Mutatis mutandis*, therefore, it is again by the use of potent personality, not submerged but subjugated, by and moving in response to an intellectual necessity, that great teaching, as well as great acting, is done. H. K. M.

Physical and Biological Science at Wembley. *J. Educ. and Sch. World*, **57**, 400–4 (1925).—Chemical science is illustrated in a separate section placed with the exhibition of industrial chemistry in the Palace of Industry. The display of physical and biological exhibits is on the ground floor of the Government Pavilion and is intended to show aspects of scientific work which are of special interest and importance at the present time. Demonstrations are a prominent feature and they are maintained by a competent scientific staff who should be consulted by visitors.

The basis of arrangement of the principal section of the physical exhibits is the subject of radiation and wave motion and the exhibits are intended to show that although their properties and the ways in which they are generated and detected vary widely, all these different rays are essentially the same thing.

In the section relating to the visible spectrum, the National Physical Laboratory shows a large image of the continuous spectrum projected on to a screen with demonstrations of the effects of radiation in the infra-red and ultra-violet regions, and the measurement of wave length by means of diffraction grating. Whenever possible, where an effect is shown in one section, the corresponding effect in other sections is also shown, indicating the essential similarities between the different forms of radiation. Thus, Sir Herbert Jackson provides an experiment illustrating selective absorption of visible rays, and Professor Fowler shows the Fraunhofer lines in the solar spectrum, compared with the tuned selective circuit and the phenomenon of resonance shown in the wireless section. The ionization effect is shown in the infra-red and visible regions by the photoelectric experiments of Professor Lindermann, while ionization of gases by X-rays is also illustrated.

Under X-rays we have the very beautiful effects of an electric discharge through a long tube during its evacuation; the penetration of materials by X-rays; and Sir William Bragg's use of the rays in the analysis of the structure of crystals.

Research in the structure of the atom is represented by numerous exhibits. The effect of alpha and beta rays can be seen in an experiment shown by Professor Lindermann and the ray tracks are made visible in Professor C. T. R. Wilson's apparatus. H. K. M.

Association Tendencies and Learning Ability. H. CASON AND E. B. CASON. *J. Exp. Psychol.*, **8**, 167–89 (1925).—The purpose of the study was to measure individuality of response and learning ability and determine the relation between them. Practically meaningless material was used in testing learning ability and the Kent-Rosanoff "free

association" test was used as the measure of the ability. The two experimenters used 100 students from their classes in general psychology as subjects. The experimenters were of the opposite sex and each had subjects of both sexes. The experimenters show that the results of the Kent-Rosanoff test will vary considerably with what may seem at the time to be only slight changes in the procedure. The most important of these factors seem to be the nature of instruction in regard to speed of reaction and the sex of the experimenter. While simplicity is a desirable feature in any test, this particular test cannot be given well without paying a good deal of attention to the experimental conditions. They did not find any conclusive evidence to justify the claim made by Burt and Moore that males definitely excel females in speed of reaction; but this may be due to the fact that their subjects were children.

They conclude (1) practically all college students begin the Kent-Rosanoff test with some preconceived notions in regard to the particular kind of responses desired and even with the most careful instructions the reactions are not entirely uncontrolled or free.

(2) The correlations between the individuality of response and speed of reaction to the Kent-Rosanoff test for individual subjects range from —0.11 to —0.59 with an average of —0.33 ± 0.06. If the subject's reaction is delayed, responses which are more and more foreign to the original stimulus word are formed, and his response has less probability of being a common one. The frequency value of each response, therefore, tends to be a function of the speed of reaction.

(3) There is a negative correlation between the *average* individuality of response and the *average* speed of reaction and the Kent-Rosanoff words for a group of subjects. If response with frequencies from 1 to 9 are constant, speed of reaction correlates —0.75 with responses with a frequency of 0. If responses with a frequency of 0 are constant, speed of reaction correlates —0.82 with responses with frequencies from 1 to 9. A subject who is quick in reacting is therefore more likely to give common responses than one who reacts slowly.

(4) In interpreting the results of the Kent-Rosanoff test, it is desirable to take account of the responses with frequencies from 1 to 9 as well as those with a frequency of 0.

(5) The sex of the experimenter affects the subject's performance as to the Kent-Rosanoff and learning tests. When the subjects are in a group situation taking the Otis intelligence test, however, the influence of the sex of the experimenter is not as marked. H. K. M.

The Discovery of Benzene. E. N. TRIPP. *Nature*, **115**, 909 (1925).—Tripp thinks it surprising that the statement in "Lunge" that Schelenz showed "benzol" or "benzene" to have been discovered in coal tar forty years before Faraday reported on it in 1825, should have remained so long unchallenged; and that it is fitting at this time to give it an unqualified and definite denial. Undoubtedly Neuman had benzene before him, but only as one constituent of a very impure mixture. H. K. M.

Mercury Halide: A Correction. J. J. MANLEY. *Nature*, **115**, 947 (1925).—The simplest assignable formula is $HgHe_{10}$ and not HgHe as at first given. H. K. M.

Metal Resources and the Constitution of the Earth. T. C. *Nature*, **115**, 914–5 (1925).—Speculation concerning the origin of ore deposits has been for years and is now dominated by the school of theorists who attribute a proximate and direct igneous origin to metalliferous veins generally. This problem was discussed by Sir Thomas Holland in his presidential address at the annual meeting of the Institution of Mining and Metallurgy on April 23. The elements formerly regarded as rare, such as zirconium and cerium are more abundant in the earth's crust as a whole than the familiar base metals copper, zinc, lead, and tin. Again nickel, which is produced in comparatively small amounts is ten times as abundant as lead and some hundred times as abundant as tin. Adopting the now apparently well established view that the earth has a large core of nickel-iron which is surrounded by silicate rock shells decreasing in basicity from an inner shell of pendotite to an outer one of granite-gneiss, the question is how do the heavy metals get to the surface? The two theories (1) that the metals have been brought from great depths in igneous eruptions and (2) that the metalliferous deposits have been formed by the segregation of materials originally disseminated through comparatively superficial rocks, need not be mutually exclusive and may be complementary; but after a consideration of the relative significance and merits of the two theories he infers that only a small fraction of ore deposits shows signs of transport from great depths, while the majority of those that are workable seem to be the result of simple lateral segregation and even a large proportion of these are probably derived by segregation processes in the uppermost layers.

This view has an important bearing on the problem of the duration of supplies of

metals. Supplies of lead, tin, zinc, and copper are likely to be exhausted long before those of coal and iron and Sir Thomas Holland thinks it unjustifiable to take an optimistic view of the possibilities as regards aluminium for bauxite deposits are few and small, and it remains to be proved that the metallurgical treatment of aluminium silicates is economically feasible. H. K. M.

The Discovery of Benzene. J. F. THORPE. *Nature*, **115**, 915–7 (1925).—A discussion of what may be called the first period of Faraday's work which closed with his illness of 1830. H. K. M.

Faraday as a Chemist. SIR W. J. POPE. Supplement to *Nature*, **115**, 1002–9 (1925).

The Faraday Benzene Centenary. H. E. ARMSTRONG. Supplement to *Nature*, **115**, 1010–3 (1925).

Faraday and His Contemporaries. ERNST COHEN. Supplement to *Nature*, **115**, 1014–6 (1925).—The principal addresses which were delivered in the Royal Institution during the celebration of Faraday's discovery of benzene. H. K. M.

SOCIETIES TO MEET AT CHEMICAL EXPOSITION

The list of chemical and allied societies and associations which will meet in New York during the week of the Chemical Exposition, continues to grow. In addition to the big chemical industry banquet which will be held under the auspices of a dozen or more organizations, individual meetings of a technical or business nature are being planned for the week of September 28th to October 3rd, which is Chemical Exposition Week at the Grand Central Palace, New York. Meetings which have been definitely scheduled, or are expected to be held, include an intersectional gathering of the American Chemical Society, meetings of the American Ceramic Society, Society of Chemical Industry, Technical Association of the Pulp and Paper Industry, the Salesmen's Association of the American Chemical Industry, National Association of Finishers of Cotton Fabrics, and the American Institute of Chemical Engineers. Others are expected to be added to this group before the beginning of September.

What appears to be the largest gathering of all will in all probability be the meeting of the eastern sections of the American Chemical Society. The fact that the annual meeting of the Society was held on the Coast this year, cut down the attendance from the East to a normal extent, and it is expected that a meeting in New York during the Chemical Exposition will be largely attended. All sections east of the Mississippi are expected to be represented.

CHEMISTRY'S SILK TO BE EXHIBITED

What will perhaps be the most extensive exhibition of rayon, commonly called artificial silk and more properly designated chemical silk, ever shown in America, will be displayed at the Chemical Exposition which is to be held September 28th to October 3rd at the Grand Central Palace, New York. The artificial silk industry through its various manufacturers, is going to prepare a joint exhibit of all phases of rayon manufacture, as well as weaving, finishing, and dyeing. Four or five large booths in the Exposition will be given over to the educational side of the most widely used fiber ever developed by chemistry. The exhibit will be designed from the technical side for the practical, textile man and from the educational side for the layman.

In the textile field, the rise of artificial silk has been fully as spectacular as the recent growth of the radio industry. That it has come to stay is unquestioned, according to leading textile factors. Its production, which started with a few thousand pounds in Europe, now runs far into millions of pounds each year in the United States alone. Where there was only one manufacturer in America a few years ago, there are twelve today and three or four large new plants in course of construction. The large exhibit at the Chemical Exposition next month, for this reason, will attract visitors from all over the world.

Local Activities and Opportunities

Princeton University. Dr. Hugh S. Taylor will attend the Oxford (England) meeting of the Faraday Society, October 1–2, at which a general discussion on "Photochemical Reactions in Liquids and Gases" will be held. Dr. Taylor will read a paper at the meeting and expects to take part in the general discussion. This symposium on photochemistry will be of an international character.

Dr. Charles P. Smyth is spending the summer in Europe. He was one of the eleven American delegates to attend the recent conference of the International Union of Pure and Applied Chemistry, held at Bucharest, Roumania. On invitation of Professor Debye, Dr. Smyth visited Zurich, where he delivered a lecture on "Electric Moments of Molecules."

Dr. W. V. Sessions is spending the summer vacation in visiting a number of industrial plants. At the opening of the University Dr. Sessions will have charge of the newly equipped laboratory of industrial chemistry.

Mr. John H. Wolfenden, B.A., University of Oxford (England), 1922, who held the Procter Visiting Fellowship in chemistry the past year, has accepted a teaching position at Oxford.

Dr. C. F. Fryling will continue his researches in physical chemistry another year as National Research Fellow.

The following appointments to fellowships have been made for the year 1925–26:

Boris Bruzs of Riga, Latvia, Procter Fellow in chemistry,

R. T. Major, University of Nebraska, Howard Fellow,

John R. Bates, Amherst College, Du-Pont Fellow,

S. O. Morgan, Union University, Fellow in Chemistry,

H. N. Alyea, Princeton University, Sayre Fellow in Applied Chemistry.

Professor William Foster has been serving in an advisory capacity to a committee of teachers and chemists in charge of preparing a syllabus for the schools of New Jersey.

Cornell University. Dr. T. R. Briggs, of Cornell University, has been promoted from assistant to full professor of physical chemistry and Dr. J. Papish from instructor to assistant professor of spectroscopy.

N. E. A. C. T. The first fall activity of the New England Association of Chemistry Teachers will be in the form of a joint program arranged with the Science Section of the Maine Teachers Association. The annual convention of Maine teachers is scheduled for October 29, 30, and 31, at Portland, Maine. This will be the first meeting of the N. E. A. C. T. ever held in Maine and will follow the broad policy of the Association in its attempt to reach all science teachers of New England.

The program is in charge of Mr. Harry Lyseth, Cony High School, Augusta, Maine, and is as follows:

Friday morning, October 30, 1925.

Greetings from the N. E. A. C. T., Leslie O. Johnson, President of the N. E. A. C. T.

What Boys and Girls Like in Science, W. W. Obear, Head of Science Department, High School, Somerville, Mass.

Putting the IS in Chemistry, Dr. Gustavus J. Esselen, Director of Research, Skinner, Sherman and Esselen Inc., Boston, Mass.

Scientific Motion Pictures.

Harvard University. James B. Conant, who has been doing research work abroad during the latter half of the present

academic year, has been appointed associate professor of chemistry at Harvard University. Dr. Conant was promoted from the rank of assistant professor.—*Harvard Alumni Bull.*

Massachusetts Institute of Technology. For the first time in the history of M. I. T. the total income from students is expected to fall below fifty per cent of the total income available for current expenses. Forty years ago eighty per cent of the Institute's income came from the students.—*Tech. Rev.*

Cement Kilns Use Heat Formerly Wasted. Tremendously hot gases, from cement kilns, formerly discharged into the air and wasted, are now utilized by manufacturers, and a saving of 775,000 tons of coal a year has resulted.

Discharge into the air of hot gases from powdered coal combustion in the kilns is a waste of heat which Portland cement manufacturers have long sought to eliminate, but practical means of utilizing this lost energy has appeared only in the last decade.

Temperatures in the kilns range from 2500 to 3000 degrees, and the gases emerge, after heating the ingredients of cement to melting point, at about 1300 degrees Fahrenheit. Formerly this heat merely went up the chimney, but now some forty-three of the 140 American Portland cement plants use this excess to make steam which in many cases supplies all the power needed in their mills.—*Service Science*

Finds Internal Cancers with Radium Photos. Cancer has apparently received some heavy body-blows in the research laboratories of Europe during recent months, and may possibly be on the verge of a knockout, according to Dr. Erwin F. Smith, U. S. Department of Agriculture, specialist on abnormal growths, who has just returned from a tour of cancer investigation centers on the other side of the Atlantic.

Dr. Smith told of two new methods of detecting internal tumors and cancers while they are still in the early stages and therefore more amenable to treatment.

"Drs. Kotzareff and Weyl, of Geneva," said Dr. Smith, "have discovered that if radio-colloidal substances are injected into a cancerous patient there is a selective fixation of the radium in the rapidly multiplying cancer cells. If now a sensitive photographic plate be exposed over the suspected part for some hours the outline of the tumor is visible on the plate when it is developed. At present the exact composition of the radium colloidal substances is a secret known only to Mr. Weyl.

"The other method of early diagnosis is a serum method discovered by Dr. Botelho chief of the cancer laboratory of the surgical clinic of Dr. Hartmann in the Hotel Dieu, the great hospital near Notre Dame in Paris. It consists in adding to centrifuged blood serum dilute nitric acid and an iodine reagent. Normal serum and that from non-cancerous patients remain clear after the final treatment. That from cancerous patients remains persistently clouded."

Dr. Smith told of the researches of Dr. Otto Warburg, of Berlin, who has shown that cancer cells can live for long periods without oxygen, provided they have a supply of grape sugar, whereas normal cells must have oxygen. An acid condition arises under these conditions, which is unfavorable to the growth of normal tissue, but does not stop the growth of the cancer.

The dispute as to the real cause of cancer continues lively, some scientists holding that it consists merely in the "running wild" of normal body cells, and others contending that there is a definite germ or virus that starts the cells on their career of anarchy. Dr. Smith inclines toward the latter view. He told of the work of Dr. Gye, of London, who took a filterable virus obtained from a chicken sarcoma long cultivated outside the body of its original victim, kept it in glass for a long time and through a series of dilutions that thinned the original quantity out almost to nothing, and still was able to produce cancers in experimental animals.

Dr. Gye was unable to find the organism that did the mischief, Dr. Smith stated, but his colleague Dr. Barnard was able to demonstrate it by the use of a special microscope able to detect objects as small as four one-millionths of an inch in diameter. "I have been in his laboratory and have seen the body dancing about in the culture fluid," said Dr. Smith. "It is the same type of germ as the pleuropneumonia organism, but smaller."

Another type of bacterium claimed as the cause of certain types of cancer by Dr. Ferdinand Blumenthal, of Berlin, closely resembles the organism responsible for the crowngall disease in plants.—*Science Service*

Recent Books

Physical Chemistry. Its Bearing on Biology and Medicine. JAMES C. PHILIP, O.B.E., D.Sc., F.R.S., Professor of Physical Chemistry, Imperial College of Science and Technology, London. Third edition. Longmans, Green and Co., New York; Edward Arnold, London, 1925. vii + 367 pp. 32 figures. 12.5 × 18 cm. $2.80.

The author delivered the substance of this volume as a course of lectures to biological students at the University of London in 1909. It is presented ". . . . . as a sketch of the physico-chemical basis for the modern treatment of biological and physiological problems."

This "physical chemistry" deals chiefly with the properties of solutions, including colloid solutions, the treatment centering on osmotic pressure and the interaction between the living cell and its fluid environment. There is perhaps rather more biology than the title would suggest, but everyone will have his own idea as to how the division should be made. Certainly the applications add to the reader's enjoyment and should be of especial service to the biological and medical students to whom the volume is addressed.

It marks the difference between English and American physical chemistry that so little space is allotted to chemical equilibrium, and that this subject is introduced principally in order that electrolytic equilibria may be treated. There is no mention of thermodynamics. The reviewer had rather hoped for a discussion of the applicability of the first and second laws in vital processes.

From the standpoint of teachability this should be a very good text. The author's style is good; the presentation is clear; references to original work are nearly always given; when mathematical relations are involved there is a thorough explanation of their application.

It should be noted that this book is not a complete physical chemistry and would hardly be suitable for use in a regular elementary course. There is no mention, for example, of the properties of mixed liquids, the phase rule, or the structure of matter; and the treatment of chemical reaction is decidedly limited.

ROBERT N. PEASE

Early Steps in Science. HANOR A. WEBB AND JOHN J. DIDCOCT. D. Appleton and Co., New York, 1924. xv + 691 pp. 19.5 × 13 cm. $1.68.

There are 298 illustrations including diagrams, pictures, and charts. These form an integral part of the text and in many instances there are questions asked about the illustrations which can be answered from a study of the diagram or picture. The page is attractively arranged so that the important material, the experiments, and other types of material are easily distinguished. Each chapter contains topics for discussion, field studies, directions for finding materials needed for experiments, questions for review, and experiments both for home and class use. At the end of each chapter there are numerous suggestions for further study which provide ample material for selection. The chapters are unusually long, but the material is so arranged that the sections could be used separately or certain sections might be omitted. The material is up-to-date and the text is a book of method as well as subject-matter. An unusual feature of the book is the section on "Studying the Mind at Work" and the section devoted to a discussion of elementary psychology. Preceding the index there are given directions for using as follows: (1) finding any given topic; (2) finding pictures; (3) finding experiments.

The purpose of the book, as stated in the preface, is to "create a preliminary widespread interest in science as a thing of personal importance" and the text "starts with an investigation, experiment, studies; but it will never complete or exhaust a topic. Pupils will always feel free to seek more, teachers to read further." The purpose of the book is surely realized in the variety of topics offered, the applications suggested and the emphasis in each chapter on the hygiene and personal relation to the topic discussed. The book should prove a valuable addition to our library of general science texts.

HELEN R. HOUCK

Chemistry of Engineering Materials. ROBERT B. LEIGHOU, M.S., Professor of Chemistry, Carnegie Institute of Technology. McGraw-Hill Book Co., Inc., New York, Second Edition, 1925. xvii + 538 pp. 88 figures. 13 × 21 cm. $4.00 net.

In the second edition of this well known textbook for engineering students with previous college training in chemistry, the author has added much of value. "The chapters dealing with fuels, iron and steel, corrosion, non-ferrous metals, and non-ferrous alloys have been almost entirely rewritten and a great deal of new material has been added. More attention has been given to metallurgical processes." "The chapters on boiler water, lubricants, and primary electric cells have been largely rewritten and recast." "The bibliographies at the ends of the

chapters have been omitted." This edition retains the many commendable features of the first edition and adds to them, as well as bringing the subject-matter up-to-date.

Among the many points of excellence may be noted the paragraphs on feed water treatment, on the setting of Portland cement and on electrolysis. An extended treatment of types of alloys together with an unusually clear introduction to the use of "freezing point" diagrams precedes a very extensive presentation of non-ferrous alloys and of the metallography of iron and steel. The excellent chapter on hydrometry reappears in nearly its original form. Far too many men highly versed in chemistry have no conception of the significance of the Baumé scales!

A few minor mis-statements and omissions have been noted and these, strangely enough, have persisted from the earlier edition. Rutile (p. 93) is a far more usual mineral than either brookite or anatase, and one wonders why the author writes its formula Ti_2O_4. The *wet process* is much used for making Portland cement from materials other than marl (p. 313), and no mention is made of titanium whites under white paint pigments (p. 349).

The chapters on primary and secondary cells could be further strengthened by a more consistent treatment of the nature and charge of the electric current. After an excellent treatment of primary cells in terms of electrons (p. 477) and a very lucid presentation of the relationship between the flow of electrons and what has been arbitrarily chosen as the "direction of the current," it seems regrettable that the author should offer an explanation of the action of the lead accumulator in terms of positive electricity (p. 497). The action of the Edison cell is well explained in terms of units of negative electricity (p. 508) instead of in both units as in the first edition. It is certainly better to say that "hydrogen ions will discharge" (p. 479), rather than "hydrogen ions separate out" (p. 486), when discussing the change of hydrogen ions to free hydrogen. The points just cited do not, however, detract appreciably from the general worth of the book.

It should be in the library of every engineer who desires to know something about the materials of his profession. This book cannot be too highly recommended for students of engineering. Teachers of general chemistry will find it a very valuable aid. The reviewer knows no better single source for the sort of information designed to interest boys in chemistry. The book should be on the desk of every high-school teacher of chemistry.

R. E. KIRK

Non-Metallic Minerals, Occurrence-Preparation-Utilization. RAYMOND B. LADOO, General Manager, Southern Minerals Corporation; Technical Director, Eastern Magnesia Talc Co., Inc. McGraw-Hill Book Co., Inc., New York, First Edition (1925). viii + 686 pp. 51 figures. 15.25 × 23.5 cm. $6.00 net.

In this volume the writer has covered in a general way the technology of the non-metallic minerals. The material is grouped under the usual trade headings and these are arranged alphabetically. A liberal use has been made of cross references. Under each general heading the author discusses minerals and compositions, general description, physical properties, geologic occurrence, geographic distribution, production and consumption, mining and milling, marketing and shipping, specifications and tests, and utilization. Many flow sheets of processes are given and tables of production, consumption, and prices are numerous.

"The non-metallic mineral field, as covered by this book, includes primarily those minerals of industrial importance which are mined industrially for use other than as a source of the metals. Certain minerals, such as bauxite, have both metallic and non-metallic applications and in these cases only the non-metallic mineral phases are covered. The field is also limited by omitting those minerals of organic origin used primarily as fuels. . . . . and also the natural bitumins and hydrocarbons. . . . . ."

Selected bibliographies follow each subject heading. They refer to the best treatises on that subject and include references to complete bibliographies.

This book represents a rather critical survey of a considerable amount of information hitherto available only in diverse and widely separated publications, many of which were difficult of access for the average person interested in the technology of some non-metallic mineral. The author has attempted a very difficult task and has achieved a considerable degree of success therein. The book seems to meet a very definite need in technological literature.

This publication should serve as a ready reference book for the teacher of chemistry who is always being asked, "What is it used for?" From Abrasives to Zirconium Minerals the book is a real storehouse of information and reference.

R. E. KIRK

OTHER PUBLICATIONS RECEIVED

Laboratory Questionnaire; The Laboratory. This is the report of the results of an investigation undertaken by the New England Association of Chemistry Teachers in commemoration of twenty-five years of work during which marked changes in the methods of teaching chemistry have taken place. Published in the Report of the Twenty-fifth Meeting of the N. E. A. C. T., in part, and completed in a Supplementary Report. Price fifty cents.

A questionnaire, sent to over one hundred teachers of chemistry in the secondary schools and colleges of New England, covers the subject of the what and the why of the laboratory teaching of chemistry. The persons to whom this questionnaire was sent were selected very care-

fully so as to get all types of schools and colleges represented in the summing up.

The compilation of the results of this questionnaire was made by Wilhelm Segerblom of Phillips Exeter Academy and is very full. The various opinions expressed by those who filled out the questionnaires are given and discussed in great detail.

Teachers of chemistry should have this report in their libraries. It should be in every college and university library where it can be consulted by students preparing to teach chemistry.

Copies may be obtained by writing Mr. John H. Card, English High School, Boston, Massachusetts.

S. WALTER HOYT

Tropical Scientist Advocates Alcohol Motor Fuel. Making motor alcohol from molasses and the juice of the sugar palm is now only a matter of cost because technical difficulties in the manufacture as well as in the use of the fuel by standard automobile engines have been solved, J. P. Foster, chief chemist of the Maui Agricultural Company's sugar factory in Hawaii, told the 70th annual meeting of the American Chemical Society meeting here this morning. The advantages of this new motor fuel are said to be easy starting, elimination of knocking and freedom from carbon troubles. The alcohol is denatured by the use of ammonia, pyridine or aniline which also neutralize the acidity of the fuel and the substances left over alter burning.—*Science Service*

Colleges Blamed for Students' Failure. When a student "flunks from college" or university, whose fault is it? Heretofore the failing student has usually been allowed to drop out of his classes for six months or a year to loaf or work, then return with' "his deficiencies remedied." Experiments conducted this spring by Franklin C. Paschal, professor of psychology and dean of men at the University of Arizona, lead Professor Paschal to lay most of the blame on the institutions. He reclaimed 80 per cent of a group of failing students without any loss of class time.

Professor Paschal selected 25 students from 80 who had failed in 50 per cent of their college work. These students were given provisional registration and allowed to register for a maximum of $12^1/_2$ units. They were required to present themselves three afternoons a week for supervised study. As a result, 20 were saved.

Lack of adequate high-school preparation and lack of knowing how to study were found to be the most frequent causes of failure. Laziness, Dean Paschal said, is only a symptom. Other causes were extracurricular activities, financial difficulties and general inability to carry a university program.—*Science Service*

"More about Our Windows"

Last month mention was made about the excellent show windows of our "Shopping District" advertising pages. This month let us see why the factories which supply these windows with the finished products are progressive.

The manufacturing plants are scattered here and there throughout our country; some are large, some are small; but in every case there exists a genuine appreciation on the part of the factory management of what importance chemistry plays in the manufacture of the finished article. These concerns are progressive because they have large technical staffs whose sole duty it is to make new and better products or improve the existing processes. Further, these concerns recognize the importance of generous coöperation in aiding distribution of new ideas in chemical instruction and also distribution of informational articles written in the layman's language.

If we as laymen or teachers should write to any of these progressive concerns whose wares are mentioned in our advertising pages, we would be indeed grateful because we should be granted most courteous treatment and sent valuable information. We should tell our students and our friends about these wide-awake American industries because it is just such a spirit as mentioned above that makes our country commercially and scientifically great.

READ EVERY ADVERTISEMENT

THEY ARE THE INDEX OF AMERICAN COMMERCIAL ACHIEVEMENT

INSTITUTE OF AMERICAN MEAT PACKERS

July 24, 1925.

DEAR MR. BILLINGS:

I have heard it said, that if modern civilization should be wiped out by some cosmic cataclysm which would leave only a few recorded vestiges of our varied activities for the edification of some future delving archaeologist, that said delver could not place within century accuracy the chronological setting of our chemical progress, so devoid are the official publications of the A. C. S. of that intimate human quality which reached its extreme expression in Pepys' Diary. Accordingly, there is an eminent place for our Journal of Chemical Education, redolent as it is with the intimate story of our efforts to push on to the next generation the lore we have so laboriously accumulated. This is not inviting the aforesaid cataclysm, but rather defying it, that he who digs may read.

There has unhappily developed in some of our Universities a fine, intellectual snobbishness that regards teaching as an impertinence, and research as the only activity worthy of professional attention. At heart, your true University professor loves teaching, even as he loves his research. Unfortunately we can bury our mistakes as teachers, in the trusting respect of the undeveloped mind, whereas our record as investigators must stand the fire of mature criticism.

Your University gathers in a less obvious profit from good teaching than from research output, for this latter brings immediate distinction to the institution and preferment to the individual. In this day when quantity production has invaded our Universities, when undignified competition for students is an accepted procedure, and the publicity department of the institution outweighs and outsalaries the instructing staff, it is easy to see how good teaching will suffer at the expense of more tangible publicity matter. I know men who have left University work because they loved their teaching but the trend forced them into increasing executive responsibility and a false zeal for ultra attenuated and inflated research interests.

I like the Journal of Chemical Education. I have read every number with profit and pleasure. Much strength to your right arm and to the pen of our self-sacrificing editor. You will do much to put good instruction back on a worthy plane of recognition.

Very sincerely yours,

DEPARTMENT OF SCIENTIFIC RESEARCH,

W. LEE LEWIS, *Director*